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## **Matthew Jones House: Recommendations for Treatment**

Edward G. FitzGerald

April 2016



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# **Matthew Jones House: Recommendations for Treatment**

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Final report

Approved for public release; distribution is unlimited.

Prepared for Civil Engineer Division, 733d Mission Support Group  
Joint Base Langley-Eustis  
Fort Eustis, VA 23604

Under Interagency Agreement No. W81EWF

Monitored by Construction Engineering Research Laboratory  
U.S. Army Engineer Research and Development Center  
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Champaign, IL 61822

## Abstract

The Matthew Jones House (MJH) is located on Joint Base Langley-Eustis (Eustis) (JBLE-E), Virginia. The house is a Virginia Historic Landmark (121-0006) and also listed on the National Register of Historic Places (#69000342). All buildings, especially historic ones, require regular, planned, and appropriate maintenance and repair. After identifying a variety of issues with the house for JBLE-E, architectural historians at the U.S. Army Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL) requested technical assistance from the National Center for Preservation Technology and Training (NCPTT) with analyzing existing materials, providing specifications for appropriate treatment materials, and making priority-level recommendations for MJH treatment by taking into account conditions and budget. The work's scope included the roofing, masonry, and HVAC systems of the structure. This report summarizes the research and findings by the NCPTT. It also includes an engineer's report and other supplemental information. This work will continue to assist JBLE-E in maintaining this historic building.

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## Foreword

After identifying a variety of structural issues with the Matthew Jones House and publishing those findings in a technical report,\* researchers at the U.S. Army Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL) requested technical assistance on behalf of Joint Base Langley-Eustis from the National Center for Preservation Technology and Training (NCPTT) in the development of treatment assistance and associated technical specifications for the Matthew Jones House.

The NCPTT provided two reports, a preliminary recommendation for the roofing system (TAR-2015-5) and a final report (TAR-2015-6) that incorporates the preliminary report and is reproduced in this contract report.

*Adam Smith, MArch*  
*Project Manager*

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\* Adam D. Smith and Sunny E. Adams, *Matthew Jones House: Historic Maintenance and Repair Manual*, ERDC/CERL SR- 14-6, (Champaign, IL: U.S. Army Engineer Research and Development Center, 2014).

## Preface

This study was conducted by the National Center for Preservation Technology and Training under Interagency Agreement No.W81EWF. The project monitor was Mr. Adam D. Smith (CEERD-CNC).

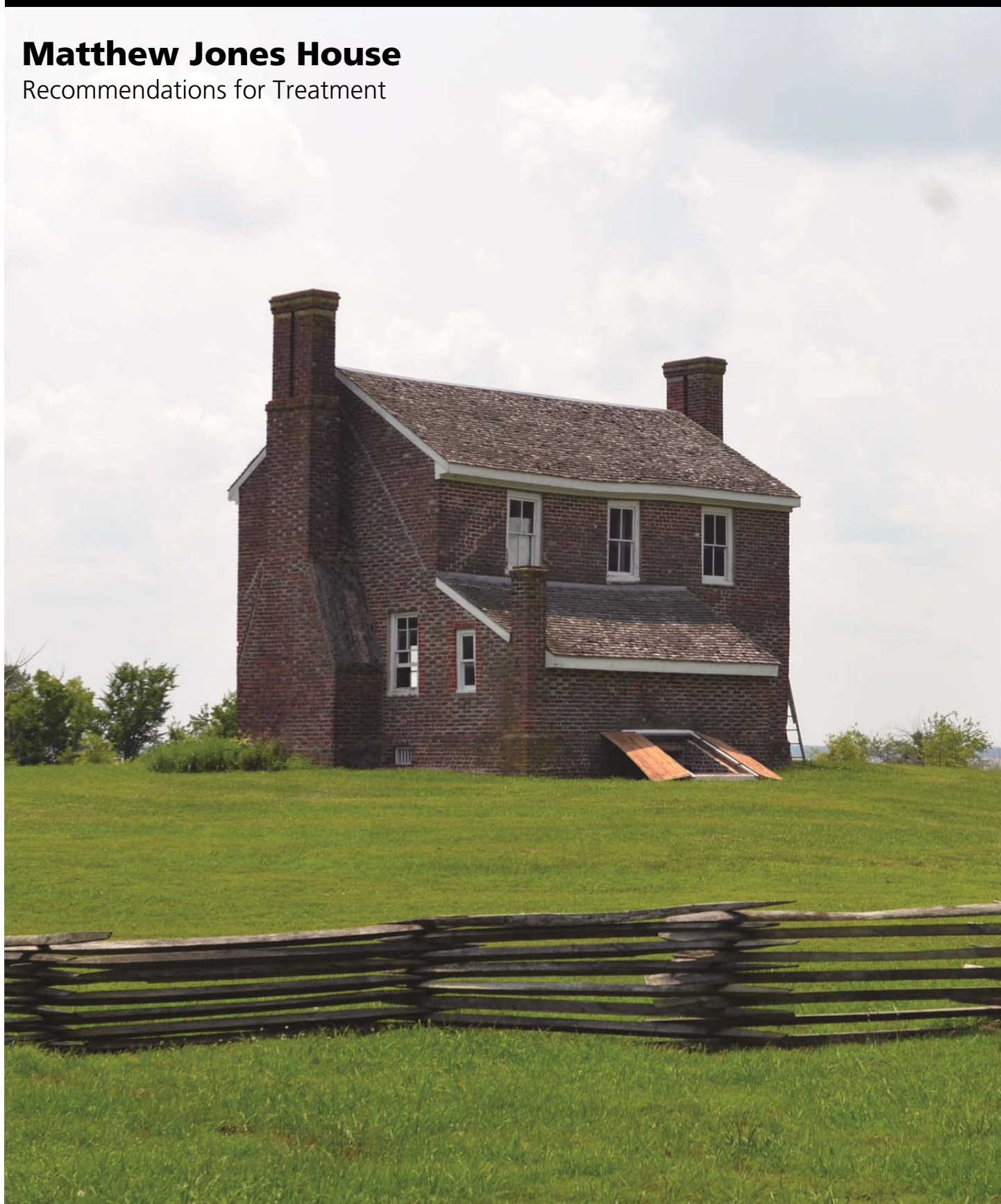
The work was monitored by the Land and Heritage branch (CNC) of the Installations Division (CN), US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). At the time of publication, Dr. Michael L. Hargrave was Chief, CEERD-CNC; and Ms. Michelle Hansen was Chief, CEERD-CN; The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti, and the Director was Dr. Ilker Adiguzel.

COL Bryan S. Green was the Commander of ERDC, and Dr. Jeffery P. Holland was the Director.



# Matthew Jones House

## Recommendations for Treatment



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# Matthew Jones House

## *Recommendations for Treatment*

### **Technical Assistance Report Series**

TAR-2015-06

September 2015

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# 1 Introduction

## 1.1 Project

In May 2015, the National Center for Preservation Technology and Training (NCPTT) was contacted by Adam Smith of the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (CERL) on behalf of Joint Base Langley-Eustis to request technical assistance in the development of treatment recommendations and technical specifications for the Matthew Jones House. The scope of the requested work included the roofing, masonry, and HVAC systems of the structure.

NCPTT staff traveled to the site to assess current conditions and determine the likely causes of the failures and possible solutions. Brick porosity and moisture content were measured in-situ, and samples of mortar, salts, and paint were removed for off-site testing. Recommendations were tailored and prioritized based on the most immediate needs and budget of the client.

The following report summarizes the findings of the materials analysis. Following the introductory information regarding the study methodology, the report discusses the findings of the research and then makes recommendations for appropriate restoration materials. All mounted paint cross-sections have been labeled and permanently housed and will be archived at BCA's Philadelphia office unless otherwise requested by the client. All extracted aggregate from the masonry materials will be submitted to the client with a hard copy of the report.

Field work for this report was conducted by Edward G. FitzGerald and Sarah M. Jackson, Architectural Conservators, NCPTT, and the recommendations and report were authored by FitzGerald. NCPTT was assisted by Michael C. Henry, of Watson & Henry Associates, Bridgeton, NJ, who conducted an analysis of the HVAC/indoor environmental control systems and provided general observations and recommendations for the structure as a whole. The above parties conducted a site visit to the structure on June 10 and 11, 2015, and were joined Adam Smith, CERL, and Christopher McDaid, Joint Base Langley-Eustis.

Preliminary roofing recommendations and specifications were previously delivered to CERL on July 21, 2015 (TAR-2015-05).

## 1.2 Building History

The Matthew Jones House (MJH) is located on Joint Base Langley-Eustis near Williamsburg, Virginia. The house has been listed on the National Register of Historic Places and as a Virginia Historic Landmark. The house was stabilized in 1992 by the National Park Service's Historic Preservation Training Center to be used as an architectural study museum with architectural features labeled.<sup>1</sup>

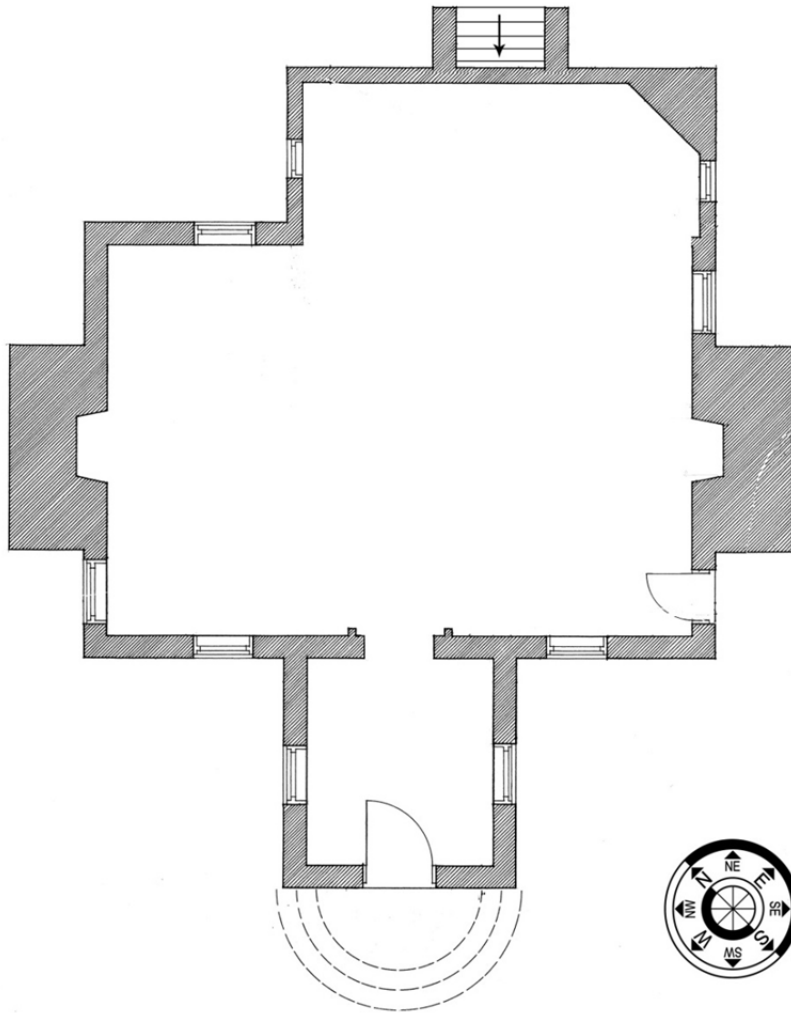
The MJH is located on the northwest bank of Mulberry Island. The structure illustrates the transition of architectural styles from the post-medieval vernacular to Georgian to Victorian. The original (Period I, ca.1725) construction was posts that extended in the ground for structural support. The original house was constructed as a one-and-a-half-

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<sup>1</sup> Construction Engineering Research Laboratory, U.S. Army Engineer Research and Development Center, U.S. Department of Defense, "Matthew Jones House: Historic Maintenance and Repair Manual," ERDC/CERL SR-14-6, by Adam D. Smith and Sunny E. Adams (Champaign, IL: U.S. Department of Defense, 2014).

story building. In 1730 (Period II) the house was significantly rebuilt with brick and the two story tower was added to the front with a lean-to added to the rear. Starting in 1893 (Period III) led to major addition of a second floor and the chimney stacks were extended to accommodate the addition.<sup>2</sup> All that survives from the Period I house are four framing members and the two chimneys.

\*The names of rooms, building elements, and other terminology used in previous reports are adopted here wherever possible to avoid confusion.



**Figure 1. Building footprint showing orientation of elevations referred to in this report.**

<sup>2</sup> Willie Graham, et al., "A Preservation Plan for the Matthew Jones House: Fort Eustis, VA," Technical Report Series No. 3 (Williamsburg, VA: William and Mary Center for Archaeological Research, 1991).

## 2 Summary Recommendations

### 2.1 Building Use

- Building used for archeological storage/artifact processing (downstairs) primarily during Spring and Summer.
- Office space used for storage.
- Tours as requested ( $\leq 30$  people)
- 2 annual events held in Oct. and April
- Total 50-75 visitors per year

## 3 Administrative Data

### 3.1 Locational Data

**Site Name:** Matthew Jones House

**Location:** Harrison Road and Taylor Avenue, Joint Base Langley-Eustis, Fort Eustis, VA

**Coordinates:** 37°09'36.4"N 76°36'11.0"W (centroid)

**Owner:** Department of Defense, Department of the Air Force, Joint Base Langley Fort Eustis

**Original Use:** Residence                      **Present Use:** Museum/Office/Storage

**Date of Construction:** ca. 1725 (with later additions ca. 1730 and in 1893)

**NR:** Listed              **Ref. No.:** 69000342              **HABS/HAER Survey No.:** HABS VA-163

### 3.2 Related Studies

Existing studies reviewed for this report includes the following (listed oldest to most recent) \*

Historic American Buildings Survey, National Park Service, U.S. Department of the Interior, "Matthew Jones House, Newport News, Newport News, VA," HABS VA-163 (Washington, DC: U.S. Department of the Interior, 1940), available at <http://www.loc.gov/pictures/collection/hh/item/va1038/>.

Willie Graham, et al., "A Preservation Plan for the Matthew Jones House: Fort Eustis, VA," Technical Report Series No. 3 (Williamsburg, VA: William and Mary Center for Archaeological Research, 1991).

Williamsport Preservation Training Center, National Park Service, U.S. Department of the Interior, "Record of Treatment: Matthew Jones House Preservation/Rehabilitation Project," by Chris Robinson (Williamsport, MD: U.S. Department of the Interior, 1993).

Construction Engineering Research Laboratory, U.S. Army Engineer Research and Development Center, U.S. Department of Defense, "Matthew Jones House: Historic Maintenance and Repair Manual," ERDC/CERL SR-14-6, by Adam D. Smith and Sunny E. Adams (Champaign, IL: U.S. Department of Defense, 2014).

## 4 Roof System

### 4.1 Description

The Matthew Jones House (MJH) is a two story, rectangular building intersected by a two story entrance structure (referred to as a tower in previous reports) on the front of the house and a one story addition at the rear. The roof system consists of a cross-gable roof over the main block bisected by the gable roof of the tower and a lower shed roof over the rear chamber. The main northwest-southeast roof has slopes of 8:12, the northeast-southwest roof above the tower has slopes of 14:12, and the shed roof has a slope of 7:12.<sup>3</sup>

The entire roof is clad with tapered, quarter-sawn white oak shingles, installed with a 4½ inch exposure. Shingles measure 16 inches long, approximately ⅜ to 7/16 inches thick at the butt end, and are of random widths ranging from 2½ to 5¼ inches (3½ in. average). Shingles were installed while the wood was still wet and butted tight to one another as per manufacturer recommendations.<sup>4</sup> Rake lines, eaves, and valleys were covered with roofing felt prior to the installation of shingles or flashing. Lead-coated copper flashing was reportedly used. Roof valleys are open and flashed, the northeast chimney is step-flashed, and the ridges of the main roof are capped in flashing. An apron flashing let into a brick mortar joint forms the transition from the northeast wall to the rear chamber's shed roof. Neither the main roof nor the shed were designed with gutters.

The perimeter of both the cross-gable and shed roof is trimmed with wooden soffits, fascia, frieze boards, and rake boards. Roof sheathing is comprised of wide, random width, pine boards, spaced randomly. Sheathing is full-thickness (4/4) lumber with circular saw marks apparent.



Figure 2. Front (southwest) façade of Matthew Jones House. (NCPTT, 2015)

<sup>3</sup> Slopes were measured from HABS drawings and are approximate. Historic American Buildings Survey, National Park Service, U.S. Department of the Interior, "Matthew Jones House, Newport News, Newport News, VA," HABS VA-163 (Washington, DC: U.S. Department of the Interior, 1940), available at <http://www.loc.gov/pictures/collection/hh/item/va1038/>

<sup>4</sup> Williamsport Preservation Training Center, National Park Service, U.S. Department of the Interior, "Record of Treatment: Matthew Jones House Preservation/Rehabilitation Project," by Chris Robinson (Williamsport, MD: U.S. Department of the Interior, 1993).

## 4.2 Existing Conditions

The existing shingles exhibit extensive deterioration and have reached the end of their useful life. Biological growth is present and extensive on the exterior. Mold growth on the interior may be attributed to roof leaks. Many of the oak shingles exhibit distortion (cupping along the width or curling along the length) or have split or shrunk, leaving gaps where insufficient offset exists and exposing the interior of the structure to the elements (Figure 3). While quarter-sawn oak shingles are known to have a life expectancy of up to 50 years, deterioration exhibited by the MJH roof (i.e. distorted and shrunk shingles) is also a known issue with this material. To some degree, deterioration in the roof covering can be attributed to normal “wear”. However, analyzing this wear can be informative and can aid in developing a plan for future work that addresses deficiencies and improves roof system life.

Possible factors contributing to the current condition of the roof covering include:

- Poor quality material - Some shingles may not be quarter-sawn as specified during the 1993 rehabilitation but rather, are flat-sawn, a cut more prone to warping. Newer growth timber and the prevalence of sapwood may also predispose the shingles to deterioration.
- Shingle size - Shingles 3 inches wide and smaller make it difficult to achieve sufficient offset from adjacent course joints (especially after shrinkage and cracking), predisposing the roof to leaks. Shingles cut to a greater thickness may better resist distortion.
- Sheathing size and spacing - The wide boards and narrow spacing may be limiting airflow and preventing adequate drying of the underside of shingles. Curling shingles, a condition apparent at the MJH, can occur when the rain-saturated wood begins to dry on the exposed topside while the underside remains wet.
- Improper installation - Shingles nailed too high on the shingle are more prone to curling. Shingles installed too tightly together are more prone to cupping and cracking.

**Figure 3. Northwest corner of main roof showing shingle distortion and biological growth. (NCPTT, 2015)**





Soffits, fascia, frieze boards, and rake boards were not physically inspected except where easily accessible on the shed roof. These were observed to be largely sound, however, the east end of the fascia was found to be rotten (Figure 4). Paint loss, weathering, and minor warping are visible on the rake boards on all gable ends.



**Figure 4. Replacement fascia board at east corner of rear shed is rotten and requires replacement. (NCPTT, 2015)**



**Figure 5. Soffit end and exposed sill plate end at northwest elevation of rear shed. (NCPTT, 2015)**

A poor design detail related to the exterior trim work was found at the northwest corner of the rear shed. The soffit end board in this location stops at the wall line, leaving the end grain of the shed roof sill plate (dated to Period II, c. 1730) exposed to the elements (Figure 5). It is unclear whether this detail is historic or one added during rehabilitation work (the area is not covered by HABS documentation or available historic imagery).



Roof sheathing was not physically inspected during the site visit, except where accessible from the ground floor in the rear chamber. Sheathing exhibits visible signs of water-related damage and should be inspected further to determine its condition and suitability for continued use (Figure 6).

**Figure 6. Exposed rafters and sheathing in rear chamber exhibiting signs of past and ongoing water damage. (NCPTT, 2015)**



An additional condition related to the roof system occurs at the northeast elevation. Water draining from the main roof is directed onto the shed roof and deposited directly onto the cellar doors. This is exacerbated by an existing sag in the main roof directly above the shed. The wooden doors were recently rebuilt (i.e. within the last year) using T1-11 engineered wooden siding and exhibit water-related damage including warping and rot.

### **4.3 Significance**

The current exterior of the MJH appears as it likely did in its Period III (c. 1893) configuration, when a second story was added to the structure and a new roof installed. Alterations and additions made during this period are significant to the historical development of the structure. Many of the roof framing members added during this period are remaining. At least two sets of rafter pairs supporting the tower roof appear to have been reused from earlier configurations and have been dated to Period II (c. 1730).<sup>5</sup> Most of the roof sheathing is also believed to date to Period III,<sup>6</sup> though much of this on the southwest elevation was replaced along with deteriorated roof trim on all elevations during rehabilitation work in 1993.<sup>7</sup>

The current roof covering is a replacement of an earlier wooden roof believed to date to the 1930s.<sup>8</sup> The replacement roof, installed in 1993, replicated the 1930s roof in materials and detailing (i.e. shingles and flashing were replaced in-kind). While the exact Period III roof covering configuration and materials are unknown, the wood shingles, metal flashing, and trim work are all appropriate for a structure of that era.

The MJH roof is a prominent and character-defining feature of the structure. The roofing system and appearance are part of the overall interpretation of the site and part of the

<sup>5</sup> Willie Graham, et al., "A Preservation Plan for the Matthew Jones House: Fort Eustis, VA," Technical Report Series No. 3 (Williamsburg, VA: William and Mary Center for Archaeological Research, 1991), 17

<sup>6</sup> Ibid., Appendix E.

<sup>7</sup> Record of Treatment.

<sup>8</sup> "A Preservation Plan," Appendix E.

historic record, reflecting material changes over time. In addition to contributing to the exterior appearance and overall architectural character, the roof system at the MJH is exposed and visible to the site's visitors in several locations on the interior of the structure. This is an unusual feature for house museums, where internal roof systems are normally concealed, and offers visitors a unique learning opportunity. Preservation efforts should therefore strive to maintain the historic structural members of the roof system in situ. Modern interventions necessary to the long-term preservation of the structure, such as material substitution or improved moisture protection, should not detract from the visual appearance of historic details. This position is in concordance with the Secretary of the Interior's Standards for Rehabilitation as well as the 1991 preservation plan.<sup>9</sup>

#### 4.4 Recommendations for Treatment

The following treatments have been determined appropriate and are recommended for the preservation of the MJH:

##### 4.4.1 General

1. All work should be completed in such a way as to protect existing architectural features from damage and to retain as much historic fabric as possible, with a minimum of loss.
2. Periodic maintenance is required to extend the life of the roof for as long as possible. (See 4.4.5 Inspection and Maintenance).

##### 4.4.2 Shingles

1. Shingles should be replaced with a durable material that matches the existing material in appearance.
2. Because the original (c. 1893) shingle material is unknown, several options exist that may increase service life without detracting from historic character:
  - a. Replace in-kind with quarter sawn white oak, increasing the minimum butt-end thickness. This material is not commercially-available and will have to be custom-manufactured.
  - b. Substitute with Atlantic white cedar, a local and historically appropriate shingle material that is more dimensionally stable<sup>10</sup> than white oak and has good weathering properties. Appearance will be similar to that of white oak. This material is not commercially-available and will have to be custom-manufactured.
  - c. Substitute with Alaskan yellow cedar, a commercially-available shingle material that is more dimensionally stable than white oak, has good weathering properties, and can be purchased kiln dried and impregnated with a fire retardant or wood preservative for added protection. Appearance will be similar to that of white oak.

<sup>9</sup> "Ibid., 71. U.S. Department of the Interior, The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines for Rehabilitating Historic Buildings (Washington, DC: U.S. Government Printing Office, 1992).

<sup>10</sup> <sup>10</sup> Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, *Wood Handbook: Wood as an Engineering Material*, General Technical Report FPL-GTR-190 (Madison, WI: U.S. Department of Agriculture, 2010), ch. 4, p. 6.

Shrinkage (%) from green to oven-dry moisture content			
Species	Radial	Tangential	Volumetric
White Oak	5.6	10.5	16.3
Atlantic White Cedar	2.9	5.4	8.8
Yellow Cedar	2.8	6.0	9.2

3. Minimum shingle width should be increased to 4 inches to ensure a 1½ inch gap offset from adjacent courses. 16 inch shingle length should be used to match existing. Minimum butt-end thickness should be increased to 5/8 inches.
4. Only 100% edge grain and 100% heartwood, clear of any defects should be permitted. Shingles should be either kiln or air dried to no less than equilibrium wood moisture content for the selected species and local conditions.<sup>11</sup>
5. Shingles should be installed with a 4½ inch exposure to match existing and nailed approximately 1½ inches above the exposure line. Type 316 stainless steel nails should be used. Copper nails must be used where nails penetrate flashing.

#### 4.4.3 *Flashing*

1. All existing flashings, including ridge caps, should be replaced in-kind with details to match existing.
2. Concealed drip-edge flashing should be installed at the eaves, extending 6 inches onto the roof and turned down ½ inch onto the fascia, to reduce moisture related deterioration of wooden roof trim. Exposed flashing should be scuffed by sanding with coarse-grit sandpaper and primed and painted to match adjacent wood trim.
3. A horizontal rain diverter should be installed above the first course of shingles on the shed roof directly above, and extending six inches beyond, the cellar doors.
4. All flashings and metalwork should be fabricated using lead-coated copper and fastened using copper nails.
5. Roofing felt should be installed as in 1993 along the roof perimeter and below all flashings except the ridge cap and rain diverter. (Barriers between the shingles and sheathing should be kept to a minimum so as not to inhibit airflow and drying of shingles.)

#### 4.4.4 *Wooden Elements*

1. Sheathing should be inspected further to determine its condition and suitability for continued use.
2. Soffits, fascia, frieze boards, and rake boards should be inspected further to determine their condition and suitability for continued use. Existing coatings on these elements should be scraped and sanded back to bare wood and repainted using a high quality 3-coat 100% acrylic coating system (1 primer + 2 top-coat), tinted to match existing.
3. The fascia end board at the northwest corner of the rear shed should be extended back along the rake board to cover the exposed rear shed sill plate end. Under no circumstances should this sill plate end be coated or otherwise sealed, as this will trap moisture in the wood and promote deterioration.
4. Partially deteriorated historic wooden elements may be partially replaced by cutting out areas exhibiting deterioration and patching in new in-kind replacement material.
5. Deteriorated wooden elements from the 1993 rehabilitation should be replaced to match historic elements in-kind.

#### 4.4.5 *Inspection and Maintenance*

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<sup>11</sup> The moisture content of wood depends on the relative humidity and temperature of the air surrounding it. See William T. Simpson, U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, *Equilibrium moisture content of wood in outdoor locations in the United States and worldwide*, Res. Note FPL-RN-0268 (Madison, WI: U.S. Department of Agriculture, 1998), available at <http://www.fpl.fs.fed.us/documnts/fplrn/fplrn268.pdf>

1. Wood roofs require inspection and routine maintenance to extend their life for as long as possible. The roof must be kept clean and inspected for damage to the shingles, flashing, and sheathing. Periodic maintenance inspections of the roof may reveal loose or damaged shingles that can be selectively replaced before serious moisture damage occurs. Keeping the wooden shingles in good condition and repairing the roof and flashing as needed, can add years of life to the roof.
2. The roof should be inspected 12 months after installation is complete, again at 10 years, and every 3 years thereafter. Inspections should be from a remote access device such as a bucket lift, cherry picker, or drone and should not include any foot traffic on the shingles.<sup>12</sup>
3. Repair of Splits and Holes
  - a. Repair wood shingles that are split by sliding a piece of lead-coated copper sheet metal (or “bib”) underneath the split and up under the subsequent courses. Sheet metal bibs should be cut to allow 1 inch on either side of the split and of sufficient length to penetrate under the course above. Slide bib into place and fasten with a single nail driven under the course above. Seal the split and the nail hole with sealant.
  - b. Repair shingles with holes in a similar fashion by sliding a bib underneath the hole, fastening in place and sealing with sealant.
4. Replacement of Individual Shingles
  - a. Carefully break damaged shingle apart using a hammer and chisel, making sure not to damage surrounding shingles. Gently remove all pieces of the damaged shingle, sliding them out from underneath the courses above. The course above may be pried upward slightly to ease removal of the damaged pieces. Cut the associated nails with a shingle ripper or hacksaw blade.
  - b. Select a replacement shingle of such width as to leave 3/16 inch space on each side for expansion.
  - c. Tap the new shingle into place until it hits the remaining nails. Remove the shingle and cut slots at the nail locations to such depth as to allow the shingle to be placed in alignment with the adjacent shingles.
  - d. Tap the replacement to within approximately 3/8 inches of its final position. Drive two new nails at a 45 degree angle through the shingle and under the course above. Tap the new shingle into its final position using a hammer and block.
5. Excessive biological growth on wood roof surfaces can trap moisture and encourage decay. Mold, moss, and other biological growth may be removed by applying a quaternary ammonium solution (such as D/2 Biological Solution or Wet & Forget) using a hand pump sprayer. Application should be done from a remote access device (see above). Under no circumstances should the roof be cleaned using a pressure washer.

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<sup>12</sup> See Sharon C. Park, “The Repair and Replacement of Historic Wooden Shingle Roofs,” *Preservation Briefs* 19 (Washington, DC: U.S. Department of the Interior, 1989), available at <http://www.nps.gov/tps/how-to-preserve/briefs/19-wooden-shingle-roofs.htm>

## 5 Exterior Masonry

### 5.1 Description

The exterior walls of the MJH are load-bearing brick masonry. Construction occurred in several campaigns as is documented by Graham et al.<sup>13</sup> Period II brickwork is laid in a Flemish bond with glazed headers above the water table. Bricks used for the second-story Period III addition are laid in common bond and are not glazed. Brick colors are a blend of brown and red and glazing, where present, is grey. The brick from both periods measures approximately 2 ½ x 8 ½ x 4 inches. The majority of these are hard-fired. However, a softer red brick was used on exterior corners above the water table and around window and door openings.

Portions of the exterior masonry are reconstructions dating to the 1993 rehabilitation work.<sup>14</sup> These include the rear shed chimney, the upper portion of the northwest chimney, the arch above the tower entrance doorway, and the brick walls for the cellar doors. Partial replacement and relaying of brick was conducted on all elevations but primarily in the tower entry stairs, around window and door openings, foundation vents, and along roof lines. Documentation from this work indicates that historic bricks were salvaged and re-laid wherever possible or otherwise replaced with restoration brick.

Like the brickwork, mortar at the MJH varies with age. That used on the chimneys is a buff color with large inclusions of shell and lime. That used in the walls is lighter in color and finer in texture. Both were struck with grapevine joints. However, as noted by Graham et al., the struck line was slightly wider in the earlier period.<sup>15</sup> In general, mortar joints measure approximately ½ inch wide with a ⅛ inch struck line measuring ⅓ inches deep. All mortar appears to use a lime as the cementing component.

Documentation from 1993 indicates that approximately 15% of the mortar joints were selectively raked and repointed.<sup>16</sup> Work was completed using a Type K mortar comprising three parts ASTM specification C144 sand, one part hydrated hydraulic lime, and one-quarter part “pullet sized,” crushed oyster shell. This mortar tends to be lighter and more uniform in color than that dating to earlier periods. It also appears that this mortar was used to patch areas where bricks are broken and pieces are missing.

### 5.2 Existing Conditions

The exterior masonry at the MJH is in remarkably good condition considering its age. Evidence of multiple repointing and repair campaigns can be identified by color and compositional differences of the bricks and mortar. Repointing and other masonry repairs from the 1993 rehabilitation appear to be performing well. Minor surface loss has occurred on some of the softer brickwork and minor cracking has occurred in some of the glazed header bricks. These conditions constitute normal wear for a building of this age and conservation treatment is unnecessary (and not likely to be effective, save for replacement of deteriorated materials) at this time.

Minor surface soiling, efflorescence, and biological growth are present on all facades. The most significant biological growth is apparent at all three chimney crowns, on the northeast slopes of the gabled chimney breasts, from the termination of the roof down the southeast elevation of the rear shed chimney (Figure 7), and below the water table on all

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<sup>13</sup> “A Preservation Plan.”

<sup>14</sup> “Record of Treatment.”

<sup>15</sup> “A Preservation Plan,” 41.

<sup>16</sup> “Record of Treatment.”



elevations. The concentration of biological growth in these areas is likely due to a high degree of moisture exposure and other favorable environmental conditions (e.g. shade).

The base of the wall at the southeast tower-main block juncture has deteriorated to the extent that mortar is missing and bricks have dislodged from the wall (Figure 8). This deterioration is most likely due to a concentration of rain water that drains from the roof valley above and collects along the base of the wall because of a low spot in the site grading.



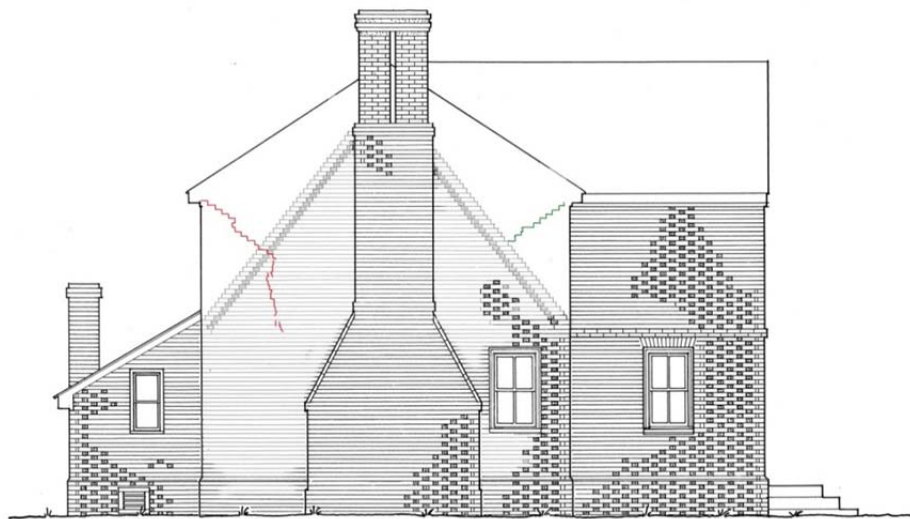
**Figure 7. Biological growth on southeast elevation resulting from rain water draining from the rear shed roof. (NCPTT, 2015)**



**Figure 8. Missing brick and mortar at the southeast tower-main block juncture. (NCPTT, 2015)**

Structural analysis and recommendations were not included in the request for technical assistance however during the site visit it was observed that the Northeast gable end wall appears to be deflecting inward in an inverted U. This raised serious concerns by those on the site visit and they strongly recommend that a structural engineer be contracted to provide in depth analysis and monitoring. The decay of the historic timber top plates, which extend out from the fireplace to the corners, may no longer be able to structurally support the wall and tie it together. A large transverse crack is apparent (Figure 9) and the wall is deflecting inward (Figure 10). The crack begins in the Period II brickwork to the north of the chimney approximately 10 feet above grade. It runs vertically through the Period II work, then across the wall coinciding with a previously pointed crack that follows mortar joints in the Period III brickwork before terminating at the northwest wall corner behind the soffit end cap. The crack measures approximately  $\frac{1}{4}$  inch at its widest point. Further investigation and analysis by a qualified structural engineer is required to determine the cause of the movement and resulting crack in the northwest wall will require. (For additional information please review Appendix A – Engineer’s Report.)

**Figure 9. Northwest elevation showing location of the active crack in red and an inactive repaired crack in green. (Modified from HABS, 1940)**



**Figure 10. Inward deflection of the northwest wall as seen from the northeast elevation. (NCPTT, 2015)**





This condition was present during the 1993 rehabilitation, when the crack in the Period III brickwork was filled-in with mortar. The crack has subsequently reopened and enlarged, indicating active structural movement. A second, apparently inactive transverse crack, mirrors the one to the north of the chimney on the south side of the wall. This crack was also filled in 1993 and does not appear to have reopened since then. Evidence indicates that movement of this wall was also an issue prior to the 1993 work. A photograph from the 1940 HABS documentation shows a filled-in crack in the Period II brickwork (Figure 11). However, the cracks in the Period III wall section do not seem to be present, suggesting that they developed in the 50 years following the documentation work.



**Figure 11. 1940 Image of northwest elevation showing repaired crack circled in red. (Modified from HABS, c. 1935)**

### **5.3 Significance**

The exterior masonry is an important character defining feature of the MJH. It distinctly illustrates changes in the structure made over time and the aesthetic principles of the various historic periods. The brickwork provides excellent examples of traditional materials and regional craft techniques, demonstrating early Tidewater brickmaking and bricklaying arts. The integrity of the brickwork is strong. The materials largely date to the 18th and 19th centuries, with some 20th century reconstructions of early elements. Preservation efforts should therefore strive to maintain the historic masonry fabric in situ. Interventions necessary to the long-term preservation of the structure, such as repointing or reinforcing, should minimize disturbance of the historic materials and visual appearance of the structure. This position is in concordance with the Secretary of the Interior's Standards for Preservation.



## **5.4 Recommendations for Treatment**

The following treatments have been determined appropriate and are recommended for the preservation of the MJH:

### **5.4.1 General**

1. All work should be completed in such a way as to protect existing architectural features from damage and to retain as much historic fabric as possible, with a minimum of loss.

### **5.4.2 Cleaning**

1. Biological growth and surface soiling do not currently pose a threat to the exterior masonry.
2. If removal of surface contaminants is desired for aesthetic reasons, masonry surfaces may be cleaned using a commercially available biocide and cleaning agent that is specially formulated for use on historic masonry. Products containing quaternary ammonium compounds as the primary active ingredient (such as D/2 Biological Solution or PROSOCO Enviro Klean ReVive) have been proven effective and safe for historic masonry and are recommended. Cleaning products and methods should be tested in a small, inconspicuous place before proceeding. (see Specification - Removing Biological Growth from Exterior Masonry and Stucco) Bleach or any product containing sodium hypochlorite should not be used.
3. Vegetation growing from cracks and mortar joints should be removed immediately by hand. If further treatment is necessary, plants may be killed with hot water. The commercially available herbicides Roundup and Garlon 4 have been tested by NCPTT and proven damaging to historic masonry. These herbicides should not be used.

### **5.4.3 Repointing and Repairs**

1. The contractor and masons selected to perform repointing work must have demonstrated experience in repointing historic masonry, ideally a minimum of five years, and should demonstrate a working knowledge of the Secretary of the Interior's Standards for the Treatment of Historic Properties.
2. Complete repointing of exterior masonry is unnecessary at this time and would result in the loss of historic materials and information.
3. Selective repointing should be conducted only where mortar is missing or loose. A detailed schedule for mortar replacement should be prepared by the contractor and reviewed by cultural resource staff in advance of execution.
4. Mortar joints should be raked to a minimum depth of 2 times (or preferably 2 ½ times) their width and be free of any loose debris before repointing. Mortar used at the MJH is relatively soft, the amount of repointing required is low, and the historic bricks are susceptible to damage. Therefore, only hand tools should be used to rake joints. (see Specification - Removal of Mortar Joints and Repointing for details).
5. A detailed mortar analysis should be performed by a qualified architectural conservator or other firm specializing in historic masonry to determine the most appropriate mix for repointing and repairs. Repair mortar should match the original in appearance, composition, and have the same or greater moisture vapor permeability and the same or lesser compressive strength. Portland cement is neither historically appropriate nor compatible with historic materials at the MJH and should not be used.

6. Multiple repair mortars may need to be formulated to match those of the different historical construction campaigns at the MJH (i.e. Period I mortar is different than that used in Period III).
7. Joints should be tooled with the appropriate width grapevine detail to match adjacent historic work.
8. Repointing of the northwest wall should not occur until an engineer has been consulted regarding the structural conditions. (See Section 5.4.2 below.)
9. Missing brick should be replaced with reproduction brick matching adjacent historic brick in appearance and have the same or greater moisture vapor permeability and the same or lesser compressive strength.
10. Broken bricks should be carefully cut out and rejoined using a conservation grade masonry epoxy or replaced with matching reproduction brick.

**Priority 1**

#### 5.4.2 *Structural Repairs*

1. Structural conditions occurring at the northwest elevation should be evaluated by a qualified structural engineer in order to isolate the cause of failures and determine the most appropriate intervention. The engineer should have prior experience, ideally a minimum of five years, working with buildings of similar age, construction, and historic significance. Proof of this work should be supplied and references reviewed prior to contracting. The engineer should demonstrate a working knowledge of the Secretary of the Interior's Standards for the Treatment of Historic Properties. (See Appendix A –Engineer's Report)

#### 5.4.3 *Inspection and Maintenance*

1. All masonry and mortar should be carefully checked for signs of deterioration, including crumbling, loose pieces, and cracking. Examine the chimneys above the roofline (through binoculars, if possible) for signs of missing brick or mortar.
2. Inspections should be done at least once a year, but would ideally be conducted on a seasonal basis.
3. See Preservation Brief 47: Maintaining the Exterior of Small and Medium Size Historic Buildings and Technical Note 46: Maintenance of Brick Masonry (Appendix D)

## 6 Interior Masonry and Plaster

### 6.1 Description

The above-grade interior walls of the MJH are primarily exposed brick covered in places by the remnants of a flat, three-coat, lime-sand plaster system applied directly to the masonry. These walls were exposed during the 1993 rehabilitation project when contemporary sheetrock and interior trim work were removed.<sup>17</sup> According to the William & Mary report, interior brickwork dates variously to Periods I, II, and III, and plasterwork dates to Period III.<sup>18</sup>

Interior bricks are generally not as well fired as that seen on the exterior of the structure, especially around the Period I fireplaces on the northwest and southeast elevations. Typically, low-fired bricks, over-fired clinkers, and deformed “seconds” are not uncommon inside wall cavities or on interior walls that were intended to be finished with plaster or some other covering. The brickwork is laid in a lime-based mortar with shell inclusions as on the exterior. Open joints and cavities in the masonry are present on all elevations, demarcating the various building campaigns and pockets for framing and trim work that are no longer extant.

Portions of the interior brickwork were rebuilt during the work conducted in 1993.<sup>19</sup> This included reconstruction of the parlor fireplace, dining room hearth, and a section above the second floor, north chamber windows. The original brick was re-laid or replaced in the parlor fireplace firebox floor and walls and along the interior walls of the southeast elevation. The dining room hearth was reconstructed using reproduction brick, belt sanded to reproduce the appearance of rubbed brickwork. Brick replacement was carried out along the dining room ceiling's joist pockets on the southwest elevation. 20th Century bricks were largely removed from interior (some remain) and replaced in 1993. Selected areas on the interior of the structure were also repointed including, the northwest elevation of the parlor, the dining room fireplace, and around voids created by joist pockets.

### 6.2 Existing Conditions

The interior masonry and plaster at the MJH exhibit widespread deterioration. A considerable amount of the original plaster is missing. The remaining plaster is cracking, detaching from the walls, or delaminating between coats (see Figure 12). The interior plaster has not been replaced due to the interpretive plan for the building. By not replacing the missing plaster this allows visitors to be better able to view the structural members and construction time periods exhibited by the house.

Mortar loss is also widespread with mortar missing or otherwise crumbling and powdering. These conditions occur on all interior elevations however, mortar failure is most apparent in both of the Period I fireplace/chimney structures (see Figure 13). These structures also exhibit extensive brick deterioration and loss, with crumbling, powdering and surface loss (i.e. “coving”) of individual weaker bricks apparent. The concentration of deterioration at these two locations is likely due to the use of a weaker low-fired brick and, possibly, a weaker mortar mix.

Interior masonry and plaster deterioration could be being accelerated by moisture issues at the MJH. High moisture levels are present as a result of rising damp and over-

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<sup>17</sup> "Record of Treatment."

<sup>18</sup> "A Preservation Plan."

<sup>19</sup> "Record of Treatment."

conditioning the space with the HVAC system. Moisture enters the soft and porous brick, mortar, and plaster, causing hygroscopic constituents of these materials (e.g. clays, uncarbonated lime, etc.) to swell. This hygroscopic expansion, followed periods of drying and contraction, gradually acts to break apart softer materials.



**Figure 12. Northwest interior elevation showing plaster in various states of deterioration. (NCPTT, 2015)**



**Figure 13. Parlor fireplace (northwest elevation) and masonry abutments exhibiting loss of bricks, plaster, and mortar. (NCPTT, 2015)**

This condition is further exacerbated by the presence of naturally occurring, water soluble salts. Samples of plaster taken from the southeast interior elevation during the site visit were analyzed for salts at NCPTT's laboratories (see Appendix B). Analysis revealed high levels of sulfates and a moderate presence of nitrates. These salts solubilize easily in water and are wicked up and carried through the masonry as a result of capillary action. As moisture evaporates, the salts fill pores in the masonry and recrystallize or "fluoresce," breaking apart the matrix of these materials in processes known as cryptofluorescence (subsurface crystallization) or efflorescence (surface crystallization). Differences in materials, including permeability, capillarity, and the degree to which they

are consolidated (i.e. how well they hold together), cause the brick, mortar, and plaster to deteriorate at different rates and detach from one another.

Salt and moisture related deterioration can be mitigated by reducing the ingress of moisture into the masonry (discussed further in Chapter 6 below) and by controlling the indoor environment (i.e. reducing potential for evaporation and salt crystallization). The restoration of the lime-based plaster on exposed brick surfaces can also help mitigate deterioration. The strong capillarity of lime acts to draw moisture out to the surface where it can evaporate and deposit salts through less-damaging efflorescence. Repairs to the brick, mortar, or plaster should not be executed until the underlying cause of deterioration has been brought under control.

### **6.3 Significance**

The interior masonry and plaster are important character defining features of the MJH. The masonry illustrates changes in the structure made over time and provides a record of building elements that are no longer extant (e.g. joist pockets for the second floor framing). The brick and plaster work both provide examples of traditional materials and craft techniques. While the interior masonry underwent partial replacement during the 1993 rehabilitation project, the integrity of the brickwork remains strong. The interior masonry and plaster largely date to the 18th and 19th centuries, with some 20th century reconstructions of original elements. Preservation efforts should therefore strive to maintain the historic fabric in situ. Interventions necessary to the long-term preservation of the structure and interpretation of the site, such as repointing, brick replacement or plaster repairs, should minimize disturbance of the historic materials and visual appearance of the interior. This position is in concordance with the Secretary of the Interior's Standards for Preservation.

### **6.4 Recommendations for Treatment**

#### **6.4.1 Plaster**

1. High moisture levels present in the walls of the MJH must be addressed prior to treatment of the historic plaster. The deterioration will continue until these issues are resolved.
2. Plasterwork at the MJH may be treated in several ways depending on the interpretive goals of the site. Retention and conservation of original historic plaster is recommended no matter which option for treatment is chosen.
  - a. Preserve existing plaster: Repair, reattach, and consolidate existing plaster. This is the least aggressive treatment.
  - b. Selective plaster restoration: Restore missing sections of plaster in selected areas based on interpretive and conservation needs. Repair, reattach, and consolidate existing plaster to preserve original fabric. This is a more aggressive treatment than preservation.
  - c. Full plaster restoration: Plaster is restored to its historic appearance, based on documentary and physical evidence. This involves repairing, reattaching, and consolidating existing plaster to preserve original fabric and restoring missing sections of plaster. This constitutes the most aggressive treatment option and does not conform to the current interpretive plan.

While each of the above options has merits worthy of further consideration, only Option A, the preservation of existing plaster, meets the interpretive plan for the building.

3. Conservation of historic plaster should be conducted only by a qualified conservator with demonstrated experience working with similar materials in buildings of similar age and historic significance.
4. Consolidation
  - a. Use of consolidants should be kept to a minimum due to the history of moisture issues affecting plaster materials at the site.
  - b. Plaster may be consolidated using lime water or a conservation-grade water-based acrylic emulsion such as Rhoplex MC 76 diluted with methanol, CO R-100, or similar.
  - c. Minimize deposition of consolidants onto finish surfaces because they can permanently change the color and light reflecting qualities of finishes.

**Priority 1**

5. Reattachment
  - a. Mechanical fasteners may be used as a temporary measure to secure sections of plaster to the masonry and prevent further detachment. Squares cut from wire mesh (or expanded lath) or plaster repair washers may be secured with screws and used to restrain plaster. Only stainless steel or plastic materials should be used. Care should be taken not to over-tension screws and drive restraints into plaster surfaces. Visible fasteners will adversely affect the historic appearance of the plasterwork and, even when hidden, do not provide sufficient support to stabilize the plaster over the long term.
  - b. An injectable grout should be used to permanently reattach plaster. Grouting is a difficult operation and can pose risks to historic fabric. Grouting should therefore only be undertaken by an experienced conservator. The filler may be formulated with a reversible, conservation grade adhesive to improve adhesion to the brick substrate. Nano-lime grouts have been used in recent years for plaster repair and offer the benefit of chemical and physical compatibility with lime based plaster. Preference should be given to grouts that are reversible, compatible with existing plaster, and have the highest possible level of permeability.
6. Patching and Filling
  - a. Cracks and small voids may be filled using an appropriate repair plaster.
  - b. A detailed plaster analysis should be performed by a qualified architectural conservator or other firm specializing in historic masonry to determine the most appropriate mix. Repair mortar should match the original plaster in appearance, composition, and have the same or greater moisture vapor permeability and the same or lesser compressive strength.
  - c. Modern joint compounds and spackle should not be used. These are typically harder than historic plaster materials and will not match the original finish appearance.

#### 6.4.2 *Brick*

1. Replacement
  - a. Deteriorated brick that has lost approximately 25% of its volume should be evaluated and considered for replacement.
  - b. Replacement brick should match the original in size, color, and texture and have approximately the same or greater moisture vapor permeability and the same or lesser compressive strength.
2. Repointing

- a. Complete repointing of interior masonry is unnecessary. Selective repointing should be conducted only where mortar is missing or deteriorated.
- b. A complete schedule and estimate for repointing interior masonry should be developed in consultation with a contractor experienced in repointing historic masonry.
- c. The contractor and masons selected to perform repointing work must have demonstrated experience in repointing historic masonry, ideally a minimum of five years, and should demonstrate a working knowledge of the Secretary of the Interior's Standards for the Treatment of Historic Properties.
- d. Mortar joints should be raked to a minimum depth of 2 times (or preferably 2 ½ times) their width and be free of any loose debris before repointing. Mortar used at the MJH is relatively soft, the amount of repointing required is low, and the historic bricks are susceptible to damage. Therefore, only hand tools should be used to rake joints. (see Specification Removal of Mortar Joints and Repointing ).
- e. A detailed mortar analysis should be performed by a qualified architectural conservator or other firm specializing in historic masonry to determine the most appropriate mix for repointing and repairs. Repair mortar should match the original in appearance, composition, and have the same or greater moisture vapor permeability and the same or lesser compressive strength. Portland cement is neither historically appropriate nor compatible with historic materials at the MJH and should not be used.
- f. Multiple repair mortars may need to be formulated to match those of the different historical construction campaigns at the MJH (i.e. Period I mortar is different than that used in Period III).
- g. Joints should be tooled to match adjacent historic work.

## 7 Foundation and Site Drainage

### 7.1 Description

The MJH rests on a brick masonry foundation with an engaged basement/cellar. The foundation exterior is surrounded on all elevations by a perimeter drainage system installed during the 1993 rehabilitation. The interior of the cellar is accessible only from the exterior through wooden bulkhead doors. This entryway was reconstructed in 1993 using reproduction bricks on concrete footings.<sup>20</sup> The cellar interior is divided into two spaces, an antechamber on the northeast side and the main cellar. Two other inaccessible spaces are located below the parlor and tower. The cellar walls have three openings for ventilation located on the northwest, southeast, and southwest elevations. All three vents have been blocked off with plywood.

The foundation underwent extensive stabilization and alteration during the 1993 rehabilitation project: bricks on the northwest interior foundation wall were re-laid; the southwest interior foundation wall was repointed; and 4 inch thick concrete slab floor was poured in the cellar with 12 and 16 inch thick footings to accommodate the load of a wood and steel support framework added at that time. Cement parging on the walls of the northwest side of the cellar antechamber also appears to have been added in 1993 (likely to stabilize the materials or structure).

A sub-surface drainage system (French drain) was installed around the exterior perimeter of the structure during the 1993 rehabilitation.<sup>21</sup> The MJH was not designed with gutters. The perimeter drainage system was intended to collect run-off from the roof and carry it away from the building, providing a drier site and eliminating the potential of rising damp. A trench measuring approximately 18 inches square was excavated around the structure. A 20 mil polyethylene vapor barrier was placed on the foundation wall exposed by excavation. The trench then received a 6 inch bed of #57 washed gravel and a 6 inch diameter bell-fitted, perforated plastic pipe was laid. This pipe was installed at a pitch of 1/8 inch per foot and connected into the newly installed waste line. Filter fabric was then placed over the pipe to prevent soils from entering the system. The excavation was then backfilled with gravel to be level with the existing grade.

### 7.2 Existing Conditions

Moisture issues affecting the above grade masonry at the MJH largely originate at the foundation. Moisture readings taken at one, two and three foot intervals up the interior foundation walls increased with height, indicating the presence of rising damp.<sup>22</sup> Parging present on the west side of the cellar antechamber exacerbates the effects of rising damp, sealing the walls and channeling water upward rather than allowing it to escape from exposed brick faces. Efflorescence is present and visible on all walls within the main cellar space. Though the foundation walls were rebuilt and repointed in 1993, mortar loss has occurred due to water-soluble salts and periods of near-complete saturation of the masonry (Figure 14). Where weaker, low-fired bricks are present, minor surface loss has occurred. Mortar loss and brick deterioration are present and extend the full height of all cellar walls.

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<sup>20</sup> "Record of Treatment."

<sup>21</sup> "Record of Treatment."

<sup>22</sup> Readings were taken using a portable resistance-type wood moisture meter and ranged from 14 to 60% wood moisture equivalent. Note that these readings are impacted by the presence of salts and only provide a relative indicator of moisture levels.



**Figure 14. Mortar joints on the east side of the wall that partitions the cellar antechamber and cellar exhibit extensive mortar deterioration and loss. (NCPTT, 2016)**



In addition to its impact on the masonry, rising damp in the cellar/foundation walls is adversely affecting structural framing components. Wood floor joists, many of which date to the 1993 work but some of which are original to the structure, were observed to be wet and actively rotting where they contact masonry (Figure 15). The steel structural support system, which rests on footings set into the concrete floor, exhibits active corrosion (Figure 16).

**Figure 15. A floor joist original to the rear shed rests directly on the west antechamber partition wall and exhibits active moisture-related rot as water wick up through the masonry into the wood. (NCPTT, 2016)**





**Figure 16. Footing of steel structural support system exhibiting corrosion. (NCPPT, 2016)**

It is unclear whether the perimeter drainage system is functioning correctly. High moisture levels present in the foundation walls suggest that it is not performing as it should. In some areas, the polyethylene vapor barrier lining the trench was not in complete contact with the foundation walls (Figure 17). This condition could be channeling water down the foundation walls increasing their moisture content. Excavation and thorough inspection of the system will be necessary to assess its ability to transport water away from the site. In addition to this system, site drainage is affected by improper grading. Low grading sloping toward the foundation was observed in areas on all elevations and is particularly evident at southeast tower-main block juncture (near the southeast entry).



**Figure 17. Crushed stone from the perimeter drainage system has filled-in behind the polyethylene vapor barrier showing that it is not in contact with the foundation wall and can allow water to bypass the system. (NCPPT, 2015)**



### 7.3 Significance

The cellar space at the MJH has limited historic significance. The historic integrity of this space has been compromised by necessary past interventions although, it does yield information about craft techniques, building campaigns, and construction technology. Only a few of the original floor joists remain and much of the original masonry has been altered. This space is generally inaccessible to the public and is not part of the site's interpretation. Treatments should strive to maintain as much of the historic fabric as possible while recognizing that the cellar serves utilitarian role and may continue to be adapted to meet the preservation needs of the whole structure.

### 7.4 Recommendations for Treatment

#### Priority 1

1. General
  - a. Move the water away from the building to reduce damage to the masonry, rising damp, and humidity
  - b. Rehabilitate existing perimeter drainage system
  - c. Install a roof drainage system
  - d. Improve surface water drainage
  - e. Reduce moisture in the cellar
2. Foundation
  - a. Repoint walls where mortar loss has occurred
  - b. Cut weeps in rendered cellar walls
  - c. Rake/repoint east side of cellar antechamber partition wall
  - d. A weep joint measuring approximately 3/8 inches wide should be cut through the concrete parging into a horizontal "bedding" mortar joint in the brickwork located on the east side of the cellar antechamber. The weep should be cut in the first mortar joint to occur approximately 4 inches up from the concrete floor. Care should be taken to properly locate the mortar joint (this may be done using a drill) so as not to cut through any bricks.

#### Priority 1

3. Drainage
  - a. Perimeter drain should be exposed and inspected
  - b. Inspect the liner of the perimeter drainage trench to determine its integrity and water tightness
    - i. Confirm that it is properly attached to the foundation and not channeling water down the walls
    - ii. If this liner is failing replace with high performance geofabric liner
  - c. Cleanouts/inspection points should be installed
  - d. Site should be re-graded to ensure flow away from bldg.
  - e. Install a roof drainage system of gutters and down spouts and discharge at least 50 feet away from the building
4. Moisture Control
  - a. Cellar bulk head doors should form an airtight seal either by rehabilitating existing doors or reconstructing
    - i. Alternatively an air-tight wall and door could be constructed at the base of the bulkhead stairs
  - b. Close and seal all openings, vents and windows to the cellar and crawl space
  - c. Construct an opening between the cellar and the crawl space

- d. Install a dehumidifier in the cellar and discharge away from the building
- e. Install a condensate pump on the air handler and discharge away from the building
- f. Determine if and where the floor drain in the cellar is draining
  - i. If this is no longer providing adequate drainage install a sump pump and discharge away from the building

## **8 Envelope Improvements**

### **8.1 Description**

One of the main reasons NCPTT was contacted was to investigate moisture issues on interior surfaces. The building managers were worried that conditioning the space was leading to the biological growth and wanted a better system to control the interior environment without damaging the historic fabric.

### **8.2 Existing Conditions**

The building managers had previously discontinued using the cooling system with the belief that the space was being over conditioned leading to biological growth, so it was not operating during the site visit. It appears that the large biological stains on the ceiling over the northwest chamber were likely caused by roof leaks.

Gaps could around windows and doors were noticed during the site visit and allow for cooler outside air to enter in the winter and conditioned air to exit in the summer. Air leakage on the main floor will lead to the HVAC system working harder to condition the space. Windows, doors, and any other openings should be closed and trimmed or reset to reduce air leakage.

The interior finishes were left in a deteriorated state to allow for visitors to examine the construction of the walls that would not be visible if it had been replaced during the 1993 renovation. While this assists in the interpretation of the building this decreases the evaporation of moisture moving through the walls. This is also accelerating the current rate of deterioration by making the remaining finish work harder. The moisture in the cellar was high which could be increasing rising damp in the walls (see 7 – Foundation and Site Drainage).

### **8.3 Recommendations**

1. Rehabilitate existing HVAC systems and disable cooling feature
2. Replace existing thermostats
3. Install dehumidifier in the basement and discharge away from the building
4. Close all openings and gaps in the walls
5. Trim or reset the windows and doors to reduce air leakage
6. Repoint with high vapour permeable mortar to create a path for moisture to leave the wall

## 9 Treatment Priorities

Priority time periods for action are intended as a general indicator of urgency. Treatments may be carried out at any time.

**Priority 1** – High or immediate priority requiring action within 1-2 years. Failure to carry out recommended treatment may result in damage to historic structure or materials.

**Priority 2**– Medium or short-term priority requiring action within 3-5 years. Recommended treatment may be temporarily postponed. However, failure to execute may eventually result in damage to historic structure or materials.

**Priority 3**– Low or long-term priority requiring action within 5 or more years. Conditions do not pose a significant threat to historic structure or materials and may be carried out at any time.

### Treatment Priorities

Element	Priority 1	Priority 2	Priority 3
Exterior Masonry	Hire an experienced engineer to evaluate and stabilize northwest gable end wall	Carry out selective repointing Repoint with appropriate mortar mix (gradient, ratios, color) Replace missing bricks at southeast tower-main block juncture	Remove biological growth with cleaners formulated for historic masonry
Manage Interior Temperature and Humidity	Rehabilitate exiting HVAC system and disable cooling function Replace exiting thermostats	Close all openings and gaps in the exterior walls Trim or reset doors and windows to reduce air leakage	Repoint failing mortar with a high vapour permeable mortar to create a path for moisture to leave the wall
Moisture Control	Move water away from the building Excavate, inspect and repair perimeter drainage system Install roof drainage system Install dehumidifier in cellar	Monitor humidity in cellar; Carry out addition moisture remediation as necessary	
Roof System	Replace roofing Install rain diverter on rear shed Paint exterior trim work	Develop and implement a maintenance plan	Monitor roof for leaks
Interior Plaster and Mortar	Plaster analysis should be done by experienced conservator Deteriorated brick should be evaluated	Reattach failing plaster Repoint failing or missing mortar Replace damaged bricks	

# **Appendix A**

## Engineer's Report



30 October 2015

Andrew Ferrell  
Chief, Architecture & Engineering  
National Center for Preservation Technology and Training  
National Park Service  
645 University Parkway  
Natchitoches, LA 71457

Subject:     **Observations and Recommendations**  
              **Building Envelope and HVAC System**  
              **Matthew Jones House**  
              **Joint Base Langley-Eustis**  
              **Fort Eustis, VA**

Dear Mr. Ferrell:

This letter summarizes my observations, documentation review and recommendations concerning the building envelope, environmental management and the HVAC system of the Matthew Jones House. The purpose of this consultation is to:

- Observe the building envelope (masonry and roof) and the HVAC system; and
- Develop recommendations for the operation and improvement of the HVAC system as it relates to the deterioration of the historic masonry and plaster finishes of the building

This letter is the project deliverable concerning the envelope, environmental management and the HVAC system. Comments concerning the roofing were previously provided to Ed Fitzgerald.

#### **SITE VISIT**

The observations were made on my site visit of 10-11 June 2015. During the site visit, the sky was clear and the exterior temperature ranged from 68°F to 91°F and the dew point temperature ranged from was 60°F to 74°F. A rain event of 0.49 inch had occurred on 09 June.

In room [3], between 2 PM, 10 June and 2 PM 11 June, the interior temperature ranged from 78°F to 84°F, the relative humidity ranged between 55%RH and 79%RH, and the dew point temperature ranged from 62°F to 74°F.

The site visit participants included Edward Fitzgerald and Sarah Jackson of NCPTT and Dr. Christopher McDaid of the 733<sup>rd</sup> Civil Engineering Division of the U.S. Army.



## OVERVIEW OF THE MATTHEW JONES HOUSE

The Matthew Jones House (37.16N, 76.60W) sits on a small rise, facing southwest and overlooking the James River, approximately 8 miles southeast of Jamestown and approximately 28 miles northwest of the Norfolk International Airport.

The Matthew Jones House consists of a two-and-one-half story brick masonry main block and front porch tower with a one-story rear shed. The house was constructed over three periods<sup>1</sup>:

- Period I (c. 1720): one-and-one-half story, timber-frame construction (possibly earthfast) with two exterior brick chimneys set on the gable end walls. An early brick kitchen was constructed in 1727;
- Period II (c. 1729-30): the Period I structure was rebuilt in brick masonry, incorporating some of the timber framing with the brick walls and reusing bricks for the Period I kitchen. The rear shed and the porch tower were added;
- Period III (1892-3): the roofline was raised for a full height second floor, the porch tower and the chimneys were extended and the rear shed was rebuilt.

The house was documented by the Historic American Buildings Survey (HABS VA-163, 7 sheets) in 1940. The HABS drawings are referenced in this report (Attachment A) solely for the convenience of orientation and room numbers, since some of the descriptive notes on the HABS drawings are no longer current.

In 1992-3, a major restoration of the house was undertaken:

- The exterior was restored to its 1893 appearance;
- The first floor spaces [1], [2], [3] and [4] were stabilized and preserved as exposed architectural artifacts;
- The second floor northwest chamber [5] was stabilized and preserved as an exposed architectural artifact but without its floor, leaving it open to room [3] hall below;
- The second stair passage, between [4] and [5], was preserved;
- The second floor tower room [6] was stabilized and preserved as an exposed architectural artifact; and,
- The second floor southeast chamber [4] was rehabilitated for functional purposes as an office and restroom.

The Matthew Jones House is interpreted to the public during two annual events in April and October and is available for student tours throughout the year; maximum tour size is 30 persons. The house is occasionally occupied during spring and summer by Fort Eustis Cultural Resources staff and interns, as well as scholars. It is heated and cooled for comfort when occupied. A limited volume of robust archaeological objects are stored at the house for processing. The house is sparsely furnished with work tables, chairs, exhibit cases, shelving units and a small inventory of office furniture.

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<sup>1</sup> *The Matthew Jones House*. Fort Eustis, VA: Fort Eustis Cultural Heritage, January 01, 2014. 22.



Matthew Jones House from South  
Photo credit: Michael C. Henry



Matthew Jones House from North  
Photo credit: Michael C. Henry



Matthew Jones House [3]&[5] from East  
Photo credit: Michael C. Henry



Matthew Jones House [3] &[5] from West  
Photo credit: Michael C. Henry

## OBSERVATIONS

### Climate

*The Matthew Jones House* is located in the Mid-Atlantic coastal region of the United States. Published data from the National Climate Data Center (NCDC) for the period 1973 to 1996 characterizes the climate at the nearby Norfolk International Airport by the following conditions (Appendix B):

- Summer median extreme high temperature: 98 °F (dry bulb), 109 grains water<sup>2</sup>/pound of dry air;  
Summer 1.0% occurrence, high temperature: 91 °F (dry bulb), 110 grains water/pound of dry air;
- Summer median high humidity ratio: 86 °F (dry bulb), 146 grains water/pound of dry air;  
Summer 1.0% occurrence, high humidity ratio: 82 °F (dry bulb), 131 grains water/pound of dry air;
- Winter median extreme low temperature: 15 °F (dry bulb), 6 grains water/pound of dry air;  
Winter 99.0% occurrence: 24 °F (dry bulb), 10 grains water/pound of dry air;
- Median daily dry bulb temperature range: 16 °F;
- Mean precipitation:  
≥5.0 inches per month: July;  
≥4.0 and <5.0 inches per month: March, August;  
≥3.0 and <4.0 inches per month: January, February, April, May, June, September, October, December;  
>2.5 inches per month: November.

Fort Eustis is located in ASHRAE/ANSI International Climate Zone 4A (Mixed Humid) and may be seasonally characterized as cold-damp to hot-humid.

Heating loads dominate from October through April, and cooling loads from May through September; Mean Annual Heating Degree Days (65°F base) are 3495 and Mean Annual Cooling Degree Days (65°F base) are 1710.

About 13% of the total annual infiltration heating load (122,764 BTU/cfm) is attributable to latent heating (humidifying to 30% RH). Infiltration cooling loads dominate June through September, with about 78% of the total annual infiltration cooling load (59,135 BTU/cfm) being attributable to latent cooling (dehumidifying to 60% RH). There are small, but important, dehumidification loads during the heating months of May and October.

Winds are prevalent throughout the year, with prevailing winds from the:

- North; Southwest quadrant December, January and February;
- North; South; Southwest and Northeast quadrants March, April and May;
- South; Southwest quadrant June, July and August; and
- South; North; Southwest and Northeast quadrants September, October and November.

Atmospheric moisture can be very difficult to control in an historic structure because high volumes of infiltration and exfiltration are generally encountered in such structures. Outside air infiltration at historic window sash and door openings is likely to be the overriding source of high levels of interior moisture and particulates, even when sources of liquid moisture entry have been abated. The problem of controlling air exchange between the interior and exterior can be exacerbated, especially in small buildings, when opening and closing of doors results in a high exchange rate.

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<sup>2</sup> 7000 grains of water weigh 1 pound.

### Interior Environmental Monitoring

There is not program for monitoring the interior environment of the Matthew Jones House.

### Building Envelope

The main block (room [2] and part of [3]) and the rear shed (room [4]) are set on a shallow cellar, but the entry tower [1] is set on an inaccessible crawl space and a substantial portion of room [3] is set over a separate crawl space. The cellar has a concrete slab-on-grade floor and is accessed from a bulkhead entry on the rear elevation of the attached shed. The crawl spaces are presumed to have earth floors.

The foundation walls and above-grade exterior walls are brick masonry; based on the HABS drawings, typical wall thicknesses are:

- 18" main block foundation;
- 14" main block first floor walls;
- 13" main block second floor front and rear walls;
- 11" main block second floor side walls; and,
- 10" kitchen shed rear and side walls.

The wall thicknesses are less at joist pockets or where the Phase II masonry was erected around the Phase I timber frame.

The 1992-3 restoration left the interior surfaces of the exterior walls in the as-found state in all rooms except the office/restroom suite [4]. Where plaster is missing, brick and mortar are exposed and the historic interior surfaces show ample evidence of active disaggregation of residual plaster, mortar and brick; this process is worse at the first floor than at the second floor and is presumably exacerbated by rising damp.

Windows are single-glazed with wood sash and frames; the windows are not weather-stripped. When closed, some of the windows have large gaps between the sash and sill or at the meeting rails.

Wood doors are rail and stile with panels and are set in wood frames; there is no weather-stripping.

The roof cladding is wood shingles and roof decking is wide boards with nominal spacing.

A detailed condition assessment of the property was prepared by the US Army Corps of Engineers in 2014.<sup>3</sup>

### Source Moisture Control

The soils at the house are identified as Urban Land, bordered by Nevarc-Uchee complex consisting of clayey marine sediments (Nevarc) and loamy and sandy marine sediments (Uchee).<sup>4</sup> Site archaeology identifies the undisturbed subsoil as silty clay with the overlying strata as including clayey loam, silty clay loam, silty clay and silt.<sup>5</sup>

Although the house is situated on a low rise, surface water drainage at the perimeter of the house is compromised in many locations, notably:

- A general depression in the yard area immediately southeast of the entry tower;
- A soil void where the southeast chimney intersects the main block near the exterior door to room [2];

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<sup>3</sup> Smith, A.D. and Adams S.E. *Matthew Jones House, Historic Maintenance and Repair Manual*. U.S. Army Corps of Engineers, Engineer Research and Development Center, Champaign, IL. 2014.

<sup>4</sup> *Web Soil Survey*. US Department of Agriculture, Natural Resources Conservation Service. Accessed 06 June 2015. <http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

<sup>5</sup> Birkett, C. *Limited Archaeological Testing of Site 44NN4, the Matthew Jones Hose, at Fort Eustis, Virginia*. Fort Eustis: Fort Eustis Cultural Resources, 2014, 22-29.

- A soil void where the southeast wall of the cellar bulkhead intersects the rear wall of the kitchen shed; and,
- A soil void where the northwest wall of the kitchen shed intersects the rear wall of the main block.

The brick masonry foundation walls were wet in the vicinity of the cellar bulkhead and the southeast corner of the main block; the remaining walls were damp.

The Matthew Jones House does not have a roof drainage system of gutters and downspouts. During the 1992-3 restoration, a perimeter subgrade drainage system was installed and was described as:<sup>6</sup>

*A sub-surface drainage system designed by HENV was installed around the exterior perimeter of the structure. This system was intended to collect run-off water from the roof and carry away from the building providing a drier site and eliminating the potential of damp rise. An excavation approximately 18" deep and 18" wide was created around the structure. A vapor barrier of 20 mil polyethylene was placed on the foundation wall exposed by the excavation. The excavation received a 6" bed of #57 washed gravel.*

*Using 6" diameter, bell fitted, perforated plastic pipe, a loop drainage system was installed within excavation. This pipe was installed at a pitch of 1/8" per foot and connected into the newly installed waste line. Filter fabric was then placed over the pipe to prevent soils from entering the system. The excavation was then filled with #57 gravel to a finish grade equal to existing soils.*

The original location of the outlet of the 1992-3 perimeter drain is unknown; based on the above description, the perimeter drain apparently discharged to the sewer line which drained to a sewage treatment plant west of the house. The sewage plant no longer exists, and the building waste line now discharges to a small duplex sewage lift station south of the house; it is not known if the perimeter drain was connected to the new sewer piping.

### Interior Environmental Management

The interior environment of the Matthew Jones House is managed by two zones of heated and cooled air delivered by a system of sheet metal and flexible ductwork:

- First floor zone:  
A horizontal fan-coil unit located in the cellar with refrigerant coils for heating and cooling and supplementary electric resistance heating; heating and cooling is provided by an air-cooled heat pump rated at 2.5 tons cooling and located directly south of the house. The first floor zone is controlled by a thermostat on the stairway wall of room [2].

Conditioned air is delivered through screened slots in the floorboards along the exterior walls of rooms [1], [2] and [3]; the efficiency of the slots has been diminished by debris and disaggregated wall material (brick, mortar and plaster) that has accumulated on the screens. Air returns from rooms [2] and [3] to the fan-coil unit through grilles located in the walls of center stairway; the return air grilles were partially blocked by an exhibit case [2] and by office furniture [3].

The condensate drain from the cooling coil in the fan-coil unit lacks a trap and proper slope and discharges to an open floor drain in the floor of the cellar bulkhead where a shallow pool of water was observed.

- Second floor zone:  
A horizontal fan coil unit located in the cellar with refrigerant coils for heating and cooling and supplementary electric resistance heating; heating and cooling is provided by an air cooled heat pump rated at 1.5 tons cooling

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<sup>6</sup> Robinson, C. *Matthew Jones House Preservation/Rehabilitation Project, Fort Eustis, Newport News, Virginia, Record of Treatment*. Williamsport Preservation Training Center, Williamsport, MD, no date. Sheet 29-30.



and located directly south of the house. The second floor zone is controlled by a thermostat on the office [4].

Conditioned air is delivered through registers in the ceiling of the office/restroom suite [4] and through the southeast wall of the of the stair passage. Air returns to the fan-coil unit through a grille located in the ceiling of the office [4].

Presumably, condensate from the cooling coil in the fan-coil is drained to the plumbing system for the second floor restroom.

The functionality of the environmental management system components was not tested and is unknown.

The attic is ventilated at the eaves and it should be noted that the attic is not separated from the conditioned spaces of the first and second floor; there is no ceiling over the second floor hall passage or the second floor tower room [6] and these spaces communicate directly with the attic space over rooms [3] and [5]. The kitchen shed, part of the first floor conditioned zone, is open to the underside of its roof.

### **Northwest Gable End Wall**

Although this consultation does not include structural observation and assessment of the Matthew Jones House, casual observation of the northwest gable end wall at rooms [3] and [5] warrants comment.

The Period II/III gable end wall is in the shape of an inverted U, and surrounds, but is not engaged with, the Period I chimney mass and fireplace opening. The Period II/III wall is weakened by the decay of the embedded Phase I timber top plate which extended from the mass of the fireplace to the corners of the building at the level of the Period I/II loft and Period III second floor. Above the line of the beam pocket, the Period II/III wall appears to be rotating inward about three axes – the two vertical axes at the exterior corners and the horizontal axis where the masonry section is weakened by the void for the no-longer extant/intact wall plate. The upper corners of the wall may also be rotating about the joint of the Phase II/III intersection. The corresponding exterior and interior crack patterns in the wall are more pronounced at the north end than the west end, possibly because the pocket for the wall plate on the west end was supplemented with steel reinforcement whereas the north end was not.



Matthew Jones House crack at Northwest

Photo credit: Michael C. Henry



Matthew Jones House Crack Detail

Photo credit: Michael C. Henry

## RECOMMENDATIONS

The potential structural issue at the rear corner of the northwest elevation requires study and monitoring. The U.S. Army should engage a structural engineer experienced with historic brick masonry structures to assess the northwest gable wall and to establish a methodology and benchmarks to document the existing and future displacements of the Period II/III wall and the Period I chimney and fireplace mass.

The remaining envelope and environmental management recommendations are based on observations of the Matthew Jones House, review of the referenced documentation, and discussions with NCPPT staff and U.S. Army personnel associated with the project. These recommendations are informed by experience with brick masonry buildings of similar age in the vicinity (the Lynnhaven House and the Adam Thoroughgood House) as well experience with moisture problems in historic masonry buildings in similar climate zones.

The recommendations are based on the understanding that:

- The preservation philosophy of the house, as set out for the 1992-3 restoration, remains the same; the interior finishes will continue to be stabilized but not be restored;
- Other than tours, occupancy of the house will be incidental to its interpretation of the building as an architectural artifact.
- Tours of the house will be limited to 30 persons at a time;
- The house will not be continuously occupied throughout the year; and,
- The house will not contain museum collections or exhibit materials that require relative humidity control.

The recommendations are intended to slow the deterioration and loss of the brick masonry and the extant interior plaster which are the result of three principal processes:

- Transport of soluble salts through the walls and damage from subflorescence near, or efflorescence on, the evaporation surface;
- Increased evaporation on the interior face of the masonry due to depressed interior relative humidity resulting from heating (winter) or cooling (summer) the HVAC; and,
- Freeze-thaw damage of masonry and plaster with high moisture content.

The recommendations are organized as follows, in *order of priority and sequence of implementation*:

- Environmental monitoring;
- Deterioration monitoring;
- Source moisture control;
- Envelope improvements;
- Interior temperature and relative humidity management for conservation of the building fabric; and,
- Interior temperature and relative humidity management for occupant comfort.

### Environmental Monitoring

Monitoring of interior and exterior environmental conditions is necessary to establish the relationship between interior conditions and the rate of deterioration of the interior plaster and masonry as well as to demonstrate the effectiveness of the recommendations in this report. This information will be used to determine if modifications to the environmental management recommendations in this report are needed, such as changing set points for dehumidification or low temperature heating.

The environmental monitoring program should measure and collect data for exterior and interior dry bulb temperature, dew point temperature and relative humidity. HOB0® data loggers and HOB0ware Pro® software, by Onset Computing Corporation are cost effective and reliable for this purpose (<http://www.onsetcomp.com/>).



- **Recommendation 1: Deploy environmental monitoring devices**

- 1a. Purchase and deploy HOBO® data loggers (model number shown) in the following locations:

Exterior conditions	UX100-023 with RS3 solar shield (mount logger on interior, sensor on exterior);
Cellar	UX100-023;
First floor, room [3]	UX100-011;
Second floor, hall passage	UX100-011;
Attic, above room [3]	UX100-011.
- 1b. Launch data loggers to record at 15 or 20 minute intervals; use the delayed launch function so that all loggers are synchronized to record on the hour.
- 1c. Download the data loggers monthly. Archive and store the data for future retrieval and analysis.
- 1d. Maintain a log or diary, noting:
  - Occupancy, vacancy and events occurring at the building;
  - Periods when doors or windows are open;
  - Operation (if any) of the HVAC system or portable heating/cooling devices;
  - Implementation of other recommendations in this report; and,
  - Any extraordinary occurrences that might affect the interior environment, such as reroofing of the building.
- 1e. When 12 months of monitoring data are available, retain an engineer experienced with environmental monitoring for historic structures to analyze and interpret the data. Analysis should emphasize the relationship of the exterior and interior conditions to the deterioration of the historic fabric.

### **Deterioration Monitoring**

Deterioration of the interior plaster and masonry at the Matthew Jones House is a relatively slow process. The rate of deterioration must be measured at a resolution and repeatability sufficient to make decisions about the effectiveness of the interventive treatments and the preventive measures. The information concerning rate of deterioration will be used with the environmental monitoring data to determine if the environmental management recommendations in this report need to be modified, such as changing set points for dehumidification or low temperature heating.

The deterioration monitoring program will have to be designed. One method would use periodic high resolution photography, under controlled lighting, of representative areas of active deterioration. Successive photos could be used to identify and quantify areas of change and/or loss.

- **Recommendation 2: Design and implement the deterioration monitoring program**

- 2a. Design and implement the deterioration monitoring program
- 2b. Analyze the results and compare to the environmental monitoring data
- 2c. Determine necessary modifications in the environmental management for the building

### **Source Moisture Control**

Source moisture control is the most effective method of addressing moisture-related deterioration in historic buildings. At the Matthew Jones House, the following measures are essential to reduce the moisture available to the historic masonry fabric.

- **Recommendation 3: Rehabilitate the existing perimeter drainage system**

- 3a. Determine and document the alignment, slope and discharge point of the perimeter drainage system. Identify and implement any necessary repairs/corrective actions.
- 3b. Expose the liner of the perimeter drainage trench and confirm its integrity and the water tightness of any seams or joints in the liner. Replace the liner with a new high performance impervious geofabric liner if the 1992-3

liner is deteriorated. Secure the existing (or new) liner to the exterior wall with a termination bar, inserting the fasteners for the bar into the brick joints, not the bricks. Neatly seal the joint between the termination bar and the masonry wall. Seal all seams.

- **Recommendation 4: Install a roof drainage system**

- 4a. Design and install a system of gutters and downspouts for all roof areas; make sure that runoff from the valley of the tower/main block roof intersection does not “jump” or overtop the corner gutter.
- 4b. Size and install a subgrade drainage system of solid pipe to serve the downspouts; discharge the roof drains at least 50 feet from the building. Do not connect the downspouts to the perimeter drain.

- **Recommendation 5: Improve surface water drainage at the building**

- 5a. Fill all low spots and surface depressions within 30 feet of the house and regrade the area to provide positive surface water runoff away from the house.

- **Recommendation 6: Reduce moisture in the cellar**

- 6a. Reconstruct/rehabilitate the cellar bulkhead doors to form an airtight seal; alternately, construct an air-tight wall and door at the base of the bulkhead steps. Either method must prevent exterior air and moisture vapor from entering the cellar.
- 6b. Close and seal all openings, vents and windows to the cellar and crawl spaces from outside.
- 6c. Provide openings in the walls between the crawlspaces and the cellar.
- 6d. Install a *Therma-Stor Ultra-Aire 70H* dehumidifier<sup>7</sup> in the cellar. Mount the dehumidifier at least 24 inches above the cellar floor. Discharge the condensate to a condensate pump and pump the condensate into the perimeter drain line. Do not discharge condensate into the cellar floor drain.
- 6e. Mount the remote humidistat in the cellar and set the humidistat to activate the dehumidifier when the interior relative humidity reaches 65%RH. This dehumidifier should be available to operate year-round and will have the added benefit of filtering some of the interior air.
- 6f. Install condensate pump on the condensate drain of the air handler and pump the condensate into the perimeter drain line. Do not discharge condensate into the floor drain.
- 6g. Determine the discharge point of the floor drain in the cellar. If necessary, construct a sump pit and install a sump pump.

### Envelope Improvements

The building envelope of the Matthew Jones House has a very high rate air and moisture vapor exchange with the exterior. The exterior masonry is porous and absorptive. The building cannot be made airtight and the masonry must not be “sealed” or “waterproofed” above grade. However, measures can be taken to reduce air and moisture vapor exchange in order to improve interior environmental management.

- **Recommendation 7: Reduce unintentional air and moisture vapor exchange with the exterior**

- 7a. Close openings gaps and openings in the exterior walls.
- 7b. Check windows and doors for gaps or poor fit in frame when closed. Trim or reset doors and window sash to reduce air leakage when closed. Windows and doors must remain operable.
- 7c. Design a repointing mortar that is more vapor permeable than the brick or the original mortar, in addition to the usual stipulations for visual match and appropriate strength for repointing mortars. High vapor permeable mortar provides a path for absorbed moisture to leave the wall rather than drying through the brick face, thereby reducing the damage to brick.

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<sup>7</sup> See <http://ultra-aire.com/products/dehumidifiers/ultra-aire-70H> for details and downloads. Specify the optional MERV 11 filter and the optional remote DEH 3000R remote digital humidistat and remote condensate pump.

### Manage Interior Temperature & Relative Humidity for Conservation of the Fabric

Interior conditions should be managed to reduce the opportunities for freeze-thaw damage, mold and accelerated drying of the masonry.

- **Recommendation 8: Reduce the potential for mold germination in the interior of the house**

- 8a: Install a *Therma-Stor Ultra-Aire 155H* dehumidifier<sup>8</sup> in the cellar and mount the dehumidifier at least 24 inches above the cellar floor. Connect the inlet of the dehumidifier to the return air plenum in the closet under the stair between [2] and [3]; connect the discharge of the dehumidifier to the floor grille along the open stud wall in [2]. Discharge the condensate to a condensate pump and pump the condensate into the perimeter drain line. Do not discharge condensate into the cellar floor drain.
- 8b. Mount the remote humidistat in [3] and set the humidistat to activate the dehumidifier when the interior relative humidity reaches 65%RH. This dehumidifier should be available to operate year-round and will have the added benefit of filtering some of the interior air.

- **Recommendation 9: Reduce the potential for freeze-thaw damage in the interior of the house**

- 9a: Rehabilitate the existing HVAC system serving the first floor. Clean the ducts, change the filters and clean the debris from the floor slots. Check the operation of the fan, electric heater and the heat pump. Make the necessary repairs for functionality.
- 9b. Disable the cooling control function of the first floor system so that the system functions as a heating and ventilating (H&V) system.
- 9c. Replace the existing thermostat for the first floor unit with a low-range digital thermostat capable of maintaining the interior between 40 and 50°F. Minimally heat the first floor zone in winter. Operate the first floor fan continuously.
- 9d: Rehabilitate the existing HVAC system serving the office suite. Clean the ducts, change the filters and clean the debris from the ceiling grilles. Check the operation of the fan, electric heater and the heat pump. Make the necessary repairs for functionality.
- 9e. Close and seal the supply air grille from the second floor HVAC system to the second floor passage.
- 9f. Replace the existing thermostat for the second floor unit with a low-range digital thermostat capable of maintaining the interior between 40 and 50°F. Minimally heat the office zone in winter. Cool (76°F) the office zone only when occupied.

### Interior Temperature & Relative Humidity Management for Occupant Comfort

The Matthew Jones House is infrequently occupied. For tours of small census (15 persons), occupant comfort is generally not a critical consideration, especially if interior temperature is similar exterior temperature. For longer duration occupancies in summer, the building may be naturally ventilated with open windows and doors, and the H&V should be operated. Local fans may also be used.

Decisions regarding reactivation of the of the first floor air conditioning, disabled under Recommendation 9, will depend on the outcomes of the environmental monitoring and the deterioration monitoring.

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<sup>8</sup> See <http://ultra-aire.com/products/dehumidifiers/ultra-aire-xt155h> for details and downloads. Specify the optional MERV 11 filter and the optional remote DEH 3000R remote digital humidistat and remote condensate pump.

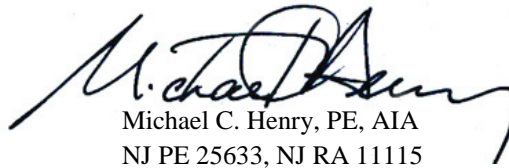
## SUMMARY

The Matthew Jones House presents a number of challenges in preventive conservation and interpretation of deteriorating historic fabric. Interior environmental management to slow the rate of deterioration must prioritize source control of all moisture. Mechanical management of interior conditions must address prevention of mold germination by limited dehumidification without exacerbating the rate of drying through the interior masonry surfaces. Mechanical management of interior conditions should sufficiently warm to reduce freeze-thaw cycles but not high enough for human thermal comfort.

Assessment of the efficacy of the recommendations is essential, and can only be accomplished through rigorous monitoring of environmental conditions and the rate of deterioration of the fabric.

Watson & Henry Associates trust that the above recommendations are helpful. Please let me know if you have further questions.

Respectfully,

A handwritten signature in black ink, appearing to read "Michael C. Henry".

Michael C. Henry, PE, AIA  
NJ PE 25633, NJ RA 11115  
VA PE 0402 036815

MCH

Matthew Jones House HVAC W&HA report 1030 2015 Final

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## **Appendix B**

### Salt Analysis

# Salt Analysis

Five plaster and mortar samples were taken during the site visit to the Matthew Jones House on June 10 and 11, 2015. The samples were brought back to NCPTT's laboratories and analyzed for soluble salts. The samples include the following:

- Two mortar samples taken (MJH-1 & 2)
- Three plaster samples taken (MJH-3 to 5)

Sample locations are recorded on building floor plans (Figures 1 and 2).

**Procedure:** 1g of crushed and dried ( $\approx 40\%$  RH) sample is added to 50mL of deionized water. Solution is stirred with a glass rod for 1 minute to ensure dissolution and suspension of salts. Conductivity of solution is measured using an OrionStar A222 conductivity meter (calibrated before use). Conductivity ( $\mu\text{S}/\text{cm}$ ), concentration in parts per million (PPM), and salinity in practical salt units (PSU) are reported. Solution is measured to ensure pH is within acceptable range (5-8 pH) for colorimetric tests. Indicative/semi-quantitative analysis is performed using colorimetric test strips (manufactured by Merk). Finally, the sample solution is filtered through  $4\ \mu\text{m}$  filter paper, the retained solids and filter paper are dried in a  $40^\circ\text{C}$  oven for 16 hours, conditioned to equilibrium moisture content (1 hour @ 60% RH) and weighed. Percent weight (% wt.) of soluble content is then calculated gravimetrically.

## Soluble Salt Content

Sample	Conductivity ( $\mu\text{S}/\text{cm}$ )	PPM	PSU	Soluble Content (% wt.)	Sulfates $\text{SO}_4^{2-}$ (mg/L)	Chlorides $\text{Cl}^-$ (mg/l)	Nitrates $\text{NO}_3^-$ (mg/L)
MJH-1	351.3	171.9	0.219	2.99	>400 (<800)	0	250
MJH-2	2747	1347	1.469	4.35	>400 (<800)	1000	500
MJH-3	2403	1177	1.281	6.99	>1600	0	500
MJH-4	1535	748	0.815	5.69	>800 (<1200)	0	50
MJH-5	1674	822	0.895	5.34	>1600	0	50



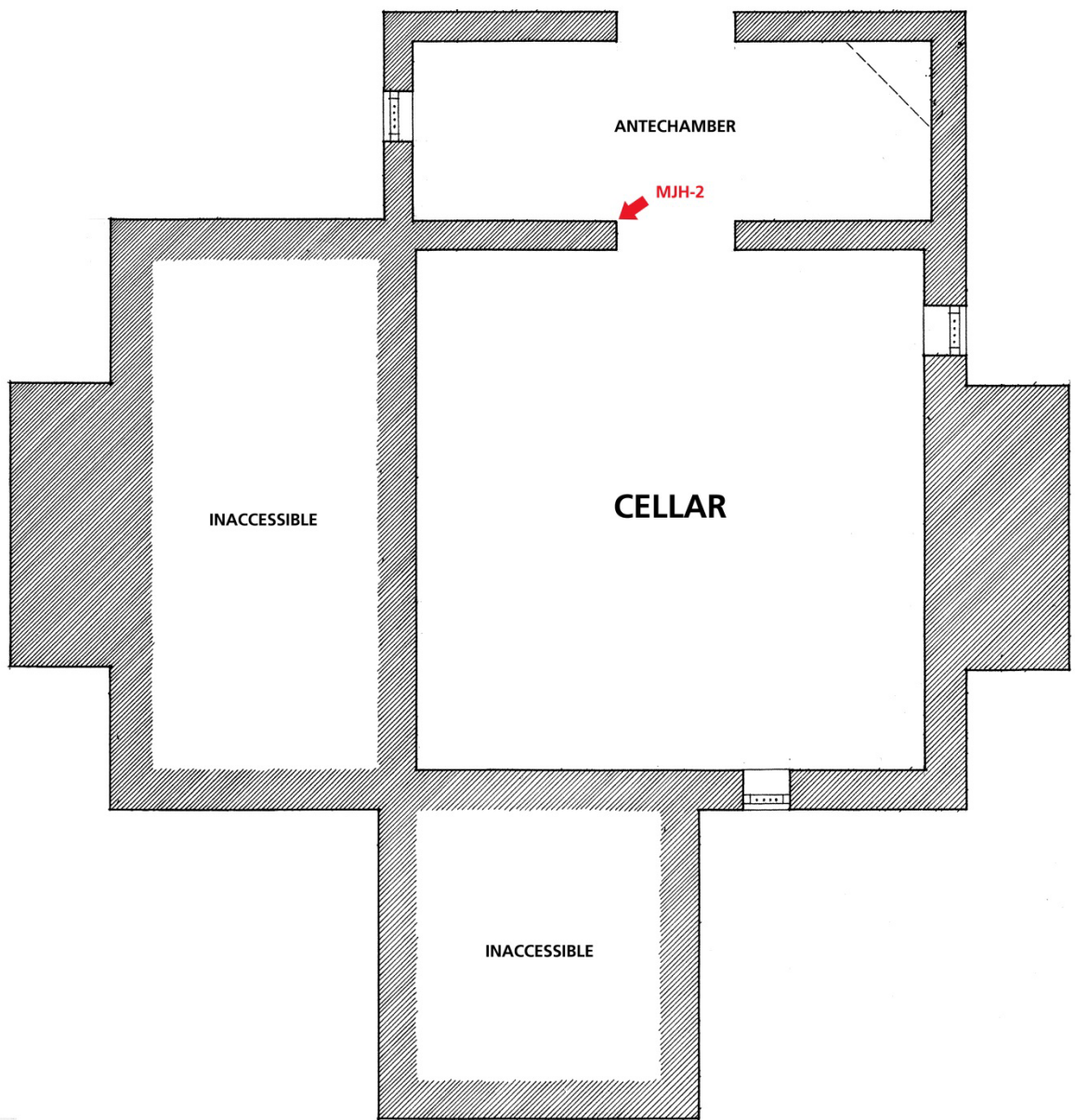


Figure 1. Cellar floor plan showing sample location and ID.

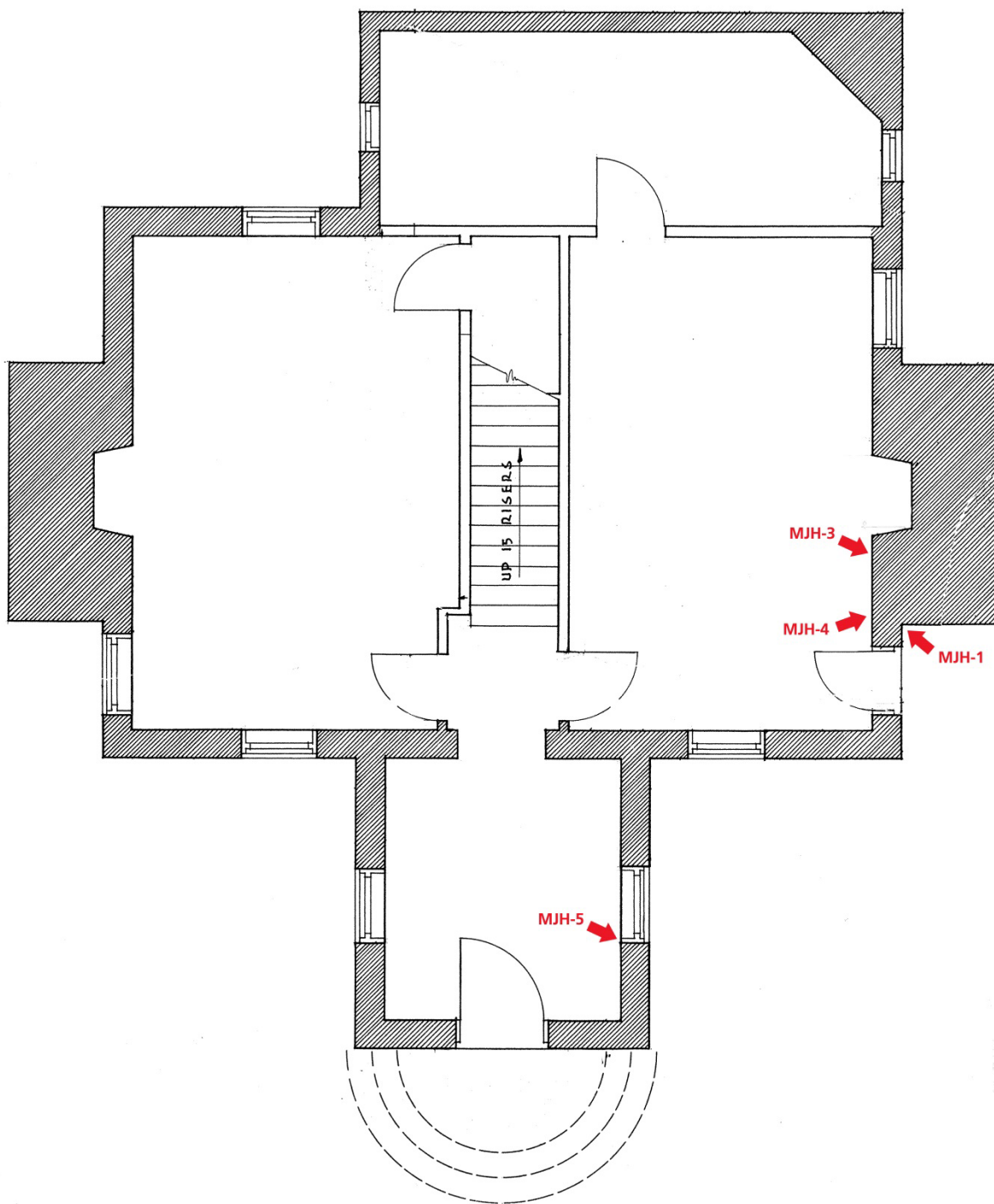


Figure 4. First floor plan showing sample locations and ID.

### **Sections**

Removal of Mortar Joints and Repointing

Preparation of Lime- and Cement-amended Mortars

Monitoring and Evaluating Cracks in Masonry

Guidelines for Evaluating the Condition of Brick Masonry and Mortar

Removing Biological Growth from Exterior Masonry and Stucco

Replication of Exterior Wooden Period Objects

Installation of Wood Shingles and Flashing

Cleaning, Preparation and Repainting of Exterior Wood Surfaces

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# PROGRAM COMMENT FOR DEPARTMENT OF DEFENSE REHABILITATION TREATMENT MEASURES

## APPENDIX 1

### SECTION 04100.01

### REMOVAL OF MORTAR JOINTS AND REPOINTING

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#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. This specification provides procedures appropriate for removing mortar and repointing historic masonry.
- B. This specification has been developed for use on historic properties (defined as any district, site, building, structure, or object that is listed in or eligible for listing in the National Register of Historic Places) and provides an overview of accepted practices.
- C. All work described herein and related work must conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties.
- D. The Contractor shall provide all labor, materials, equipment, and operations required to complete the rehabilitation work indicated herein.
- E. All work described herein and related work must have the approval of a Cultural Resources Manager, Conservator, Historic Architect, or other professional who meets the standards outlined in the Secretary of the Interior's Standards – Professional Qualifications Standards pursuant to 36 CFR 61. Such person is referred to in this document as the *Architect*.
- F. Site-specific specifications, when appropriate, will be provided by the Architect.

##### 1.02 SECTION INCLUDES

- A. Removal of mortar joints
- B. Repointing

##### 1.03 RELATED SECTIONS

- A. Section – 04100.02 Preparation of Lime and Cement-Amended Mortars
- B. Section – 04211 Historic Brick (pending issuance)
- C. Section – 04214 Terra Cotta and Ceramics (pending issuance)
- D. Section – 04500 Masonry Restoration (pending issuance)
- E. Section – 04720 Historic Cast Stone (pending issuance)

##### 1.04 REFERENCES

- A. Repointing shall conform to *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, available at the National Park Service (NPS) website at <[http://www.nps.gov/history/hps/tps/standards\\_guidelines.htm](http://www.nps.gov/history/hps/tps/standards_guidelines.htm)>.
- B. Techniques employed for repointing shall be as outlined in *Preservation Brief No. 2: Repointing Masonry Joints in Historic Masonry Buildings*, available online at the NPS website at <<http://www.nps.gov/history/hps/tps/briefs/brief02.htm>>.
- C. Techniques employed for cleaning masonry prior to repointing shall be as outlined in Preservation Brief #1: Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings.
- D. U.S. General Services Administration Historic Preservation Technical Procedures for mortar, available online at <[http://www.gsa.gov/gsa/cm\\_attachments/GSA\\_DOCUMENT/Preservation\\_Note\\_01\\_R2RQ4-y\\_0Z5RDZ-i34K-pR.doc](http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/Preservation_Note_01_R2RQ4-y_0Z5RDZ-i34K-pR.doc)>; <<http://w3.gsa.gov/web/p/hptp.nsf/a533f1f859737bc9852565cc0058d0b6/7de342045d4c63f6852565c50054b3a7?OpenDocument>>; and <<http://w3.gsa.gov/web/p/hptp.nsf/a533f1f859737bc9852565cc0058d0b6/e7518da3d776f026852565c50054b3c5?OpenDocument>>.
- E. Masonry restoration work shall comply with ACI / ASCE 530.1-88. Contractor shall maintain at least one copy of ACI / ASCE 530.1-88 on site.

#### 1.05 SUBMITTALS

The Contractor will submit a detailed schedule of the areas to be repointed, including an assessment of the problem areas and a detailed procedure for repointing, to the Architect for approval. Documentation shall include:

- 1. Existing general masonry failures that contribute mortar losses shall be noted and should be scheduled for repair prior to repointing.
- 2. Analysis of mortar type and color shall be conducted, the extent and type of analysis to be determined by the Architect.
- 3. 'Before' photo documentation of areas to be worked.

#### 1.06 QUALITY ASSURANCE

- A. Work Experience: The Contractor & masons to perform the work in this section shall have demonstrated experience in the repointing of historic masonry, ideally a minimum of five (5) years . He/she shall demonstrate a working knowledge of the Secretary of the Interior's Standards for Guidelines for Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings.
- B. Mortar removal will be undertaken by an experienced mason. The mason operating mechanical tools or power tools (when necessary) shall have demonstrated proficiency with the tools which must be approved by the Architect. The Mason/operator using the equipment must have demonstrated expertise in their proper use on historic structures, ideally a minimum of five years experience.

#### 1.07 MOCK-UPS

- A. The Contractor shall prepare mock-up installations prepared with each of the removal methods and tools that will be used for this Work at locations selected by the Architect. Test panels should not be undertaken in areas that are highly visible. Use of power and mechanical tools shall be approved by the Architect.
- B. The Contractor shall prepare two mock-up installations of each type of masonry joint style and mortar color to be installed at locations selected by the Architect. If cleaning tests are also to take place, test panels should be placed in the same area. Test panels should not be undertaken in areas that are highly visible. Each test panel shall be executed in the same manner as the final installation. Mock-ups will be reviewed after the mortar removal and again after completion of repointing. Test panels shall be a minimum area 3x3 feet for brick facades, and larger for stone facades. Test panels will be inspected for color, texture, and installation technique.
- C. If the first mock ups are unacceptable, the Contractor shall prepare up to three additional mock-ups of each mortar, joint type, and mortar color without further compensation, for approval by the Architect. Approved test area(s) shall become part of the work and shall serve as the quality standard for all subsequent work.

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered to the site in original packaging, unopened, with manufacturer's name and product identification thereon. Cementitious materials shall be protected from contamination by foreign matter and deterioration by moisture or temperature. Contaminated or deteriorated material shall not be used.
- B. Masonry materials shall be stored in such a manner as not to interfere with the operation and daily maintenance of the facility. Proposed storage locations shall be approved by the the government prior to the delivery of materials. Masonry materials shall not be stored inside the building.

#### 1.09 PROJECT / SITE CONDITIONS

- A. The normal temperature range for the work of this Section shall be when the air and surface temperatures are 40 degrees F and rising, or less than 90 degrees F and falling. When temperatures are expected to fall outside this range, the Contractor shall employ hot and cold weather procedures as published by the Masonry Institute of America, when approved by the Architect.
- B. The Contractor is responsible for protecting existing adjacent materials and surfaces during the execution of the work, and shall provide all necessary protection and follow all necessary work procedures to avoid damage to existing material assemblies not a part of the work in the Section.
- C. The Contractor shall provide visible barriers and / or warning tape around the perimeter of the work area for visitor protection and shall also provide that nearby vehicles and adjacent structures and foliage will be protected from damage during the course of the work.



- D. The Contractor shall coordinate masonry repointing with the other trades involved in exterior and interior rehabilitation work, as applicable, including but not limited to masonry cleaning, sealing, and painting.

## **PART 2 – PRODUCTS**

### **2.01 EQUIPMENT FOR RAKING AND REPOINTING**

- A. Equipment for raking joints:
  - 1. Preferred Method: Hand chisels and mash hammers
  - 2. Alternate Method: With Architect's approval: Power tools including small pneumatically-powered chisels, scaler (power chipper), and thin diamond-bladed grinders. Power saws are not generally recommended.
- B. Equipment for repointing:
  - 1. Mortar pan mill or equipment for mortar mixing
  - 2. Plastic buckets, hoe, wooden mallet
  - 3. Mortar board, hawk, trowels, pointing rod
  - 4. Natural bristle or nylon brushes (metal bristle brushes are NOT to be used)

### **2.02 MORTAR SELECTION CRITERIA: See Sections 04100.02 and 04400.01.**

- A. Repair mortar shall match as closely as possible the characteristics of the historic pointing mortar.
- B. Repair mortar shall match the color, texture, strength and tooling of the historic pointing.
- C. Sand shall match the sand of the historic mortar, when possible
- D. Mortar shall have greater vapor permeability and be softer, measured in compressive strength, than the masonry units.
- E. Mortar shall be as vapor permeable and be as soft or softer, measured in compressive strength, than the existing historic mortar.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. The restoration methods and materials selected for a specific structure shall take into account the total construction system of the building to be worked upon, including different masonry and mortar materials, as well as non-masonry elements that may be affected by the work.
- B. The extent of the repointing, whether partial or sectional repointing, complete facades or features, or total structure or building, shall be reviewed by the Architect on site prior to

beginning operations. The Contractor shall submit a repointing schedule, including methods and materials to be used for approval before work starts.

- C. Prior to commencing the work, the Contractor shall complete a schedule to be approved by the Architect of the proposed work, to address the condition of the mortar and masonry.
- D. The Contractor shall protect adjacent materials, installed non-masonry materials, and openings.
- E. Manufacturer's instructions for mixing mortar and installation of masonry and equipment shall be followed. Masonry shall conform to ASTM C270 - 07a Standard Specification for Mortar for Unit Masonry
- F. Masonry cleaning shall be completed prior to beginning raking and repointing work. Cleaning shall be in accordance with the Secretary's Standards and in conformance with National Park Service, Technical Preservation Services Preservation Brief #1: Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings.

### 3.02 SYSTEM FOR JOINT REMOVAL

- A. The areas selected for repointing, if partial or selective repointing is to be done, shall be designated and marked off with an impermanent material.
- B. Removal Methods:
  - 1. Preferred Method: removal of mortar by hand with a hand chisel and mash hammer. This method produces the least damage and is preferred for masonry with thin joints and for brick.
  - 2. Alternative Method #1: removal with power tools such as pneumatic chisels and grinders. Power saws are not recommended for use on most brick walls or thin joints. Small pneumatically powered chisels are generally effective for use on historic buildings, providing the operator is skilled. Grinders with thin diamond blades can be used for horizontal joints on hard portland cement mortars.
  - 3. Alternative Method #2: combined use of power tools and hand chiseling methods are generally recommended and achieve the highest degree of success when properly executed.
- C. Specifications for Removal:
  - 1. Mortar shall be removed to a minimum depth of 2 to 2 ½ times the width of the joint but not less than ¾ inch.
  - 2. Chisels and power tools are to be the appropriate size to fit cleanly into mortar joints without damage to surrounding surfaces.
  - 3. Loose or disintegrated mortar beyond the minimum depth shall be removed.
  - 4. Removal of the mortar shall be done in a manner that does not score, chip, or otherwise damage masonry units or adjacent elements.

5. Mortar should be removed cleanly from the masonry units, leaving square corners at the back of the cut.
6. If using a grinder to rake head joints, the Contractor shall switch to the smallest diameter blade possible to make the deepest cut without overrunning the ends of the joint and cutting into the material above or below. Top and bottom of the head joints shall be finished with a chisel.
7. Use a hand chisel to finish joints adjacent to door and window openings to avoid damage to frames and trim.
8. If work is found unacceptable by the Architect, all raking shall cease without additional cost to the Owner until deficiencies in tools, workmanship, or methodology have been corrected to the Architect's satisfaction.

### 3.03 SYSTEM FOR REPOINTING

A. The Contractor shall inspect all joints to receive mortar prior to commencing work:

1. After removal of the old mortar, joints shall be blown clean with compressed air (40-60 psi) to remove all loose particles and dust.
2. Prior to repointing, joints shall be dampened with pressurized water (100-150 psi). Joints shall be damp with no visible standing water.
3. Dampen absorbent masonry surfaces, such as limestone, sandstone, and common brick, to which mortar will adhere.

B. Filling Joints:

1. Fill the deeper areas first, compacting the new mortar in several successive layers.
2. Apply successive amounts of mortar in 1/4-inch layers.
3. Allow each layer to harden before application of the next layer.
4. Apply the final layer flush with masonry units, except where old bricks or stones have worn, rounded edges, the final mortar layer should be recessed slightly from the face of the masonry. Do not feather-edge mortar over chipped or damaged edges.

C. Finishing:

1. Allow the final layer to set until "thumb-print hard" and tool to match the historic joint. Proper timing is important for uniform color and appearance of the mortar.
2. Remove excess mortar from the edges of the joints with a natural bristle or nylon brush after mortar has dried but before the mortar is initially set (approximately 1-2 hours).

D. Curing:

1. Periodically wet mortar joints after the mortar joints are thumb-print hard and have been tooled (especially important with high-lime content mortars, such as Type O, Type K, and especially Type L). Misting with a hand sprayer with a fine nozzle for one to two days is recommended.
2. Where ambient temperatures exceed 80 degrees F or where wind speeds exceed 20 mph, cover walls with burlap after repointing to keep walls damp and protected from direct sunlight. If plastic is used, it must be tented out and not placed directly against the wall.
3. Allow new mortar to cure for at least 30 days prior to exposure to other repairs.

### 3.04 FINAL REPORT

The Contractor and Architect shall:

- A. Revisit the site after the new mortar has cured at least 30 days to compare the finish and color of the repair to see if the desired affect has been achieved.
- B. Document the work and finished product with photographs, both 'before' and 'after'.
- C. Provide a written summary of the project and results upon final inspection and approval. The summary shall outline steps taken or new findings not specified in the initial documentation.

END OF SECTION

**PROGRAM COMMENT FOR DEPARTMENT OF DEFENSE  
REHABILITATION TREATMENT MEASURES**

**APPENDIX 2**

**SECTION 04100.02                      PREPARATION OF LIME AND CEMENT-AMENDED MORTARS**

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**PART 1 - GENERAL**

**1.01      DESCRIPTION**

- A.    This specification provides procedures appropriate for preparing lime and cement-amended mortars for use in repointing historic masonry.
- B.    This specification has been developed for use on historic properties (defined as any district, site, building, structure, or object that is listed in or is eligible for listing in the National Register of Historic Places) and provides an overview of accepted practices.
- C.    All work described herein and related work must conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties.
- D.    The Contractor shall provide all labor, materials, equipment, and operations required to complete the rehabilitation work indicated herein.
- E.    All work described herein and related work must have the approval of a Cultural Resources Manager, Conservator, Historic Architect, or other professional who meets the standards outlined in the Secretary of the Interior's Standards – Professional Qualifications Standards pursuant to 36 CFR 61. Such person is referred to in this document as the *Architect*.
- F.    Site-specific specifications, when appropriate, will be provided by the Architect.

**1.02      SECTION INCLUDES**

- A.    Mortar selection
- B.    Preparation of lime mortar
- C.    Preparation of cement-amended mortar

**1.03      RELATED SECTIONS**

- A.    Section 04100.01 – Removal of Mortar Joints and Repointing
- B.    Section 04211 – Historic Brick (pending issuance)
- C.    Section 04214 – Terra Cotta and Ceramics (pending issuance)
- D.    Section 04400.01 – Identifying Masonry Types and Failures
- E.    Section 04500 – Masonry Restoration (pending issuance)

**1.04      REFERENCES**

- A. *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, available at the National Park Service (NPS) website at <[http://www.nps.gov/history/hps/tps/standards\\_guidelines.htm](http://www.nps.gov/history/hps/tps/standards_guidelines.htm)>.
- B. Use and types of mortar are found in *Preservation Brief No. 2: Repointing Masonry Joints in Historic Masonry Building*, available online at the NPS website at <<http://www.nps.gov/history/hps/tps/briefs/brief02.htm>>.
- C. U.S. General Services Administration Historic Preservation Technical Procedures for Mortar, available online at <http://w3.gsa.gov/web/p/hptp.nsf/a533f1f859737bc9852565cc0058d0b6/7de342045d4c63f6852565c50054b3a7?OpenDocument> and <<http://w3.gsa.gov/web/p/hptp.nsf/a533f1f859737bc9852565cc0058d0b6/e7518da3d776f026852565c50054b3c5?OpenDocument>>.
- D. Weaver, Martin E. *Conserving Buildings: A Manual of Techniques and Materials*. Revised edition. New York: John Wiley & Sons and the Preservation Press, 1997.
- E. ASTM C207, *Standard Specification for Hydrated Lime for Masonry Purposes*
- F. ASTM C206, *Standard Specification for Finishing Hydrated Lime*
- G. ASTM C144, *Standard Specification for Aggregate for Masonry Mortar*.
- H. ASTM C150, Type II, *Standard Specification for Portland Cement*.
- I. ASTM C979, *Specification for Pigments for Integrally Pigmented Concrete*.
- J. ASTM C170 – Compressive Strength of Natural Building Stone
- K. ASTM C5 Standard Specification for Quicklime for Structural Purposes

#### 1.05 SUBMITTALS

- A. The Contractor shall submit a detailed schedule of the areas to be repointed, including an assessment of the problem areas, a historic mortar analysis, and a detailed procedure for repointing, to the Architect for approval:
  - 1. Submit data indicating proportion or property specifications used for mortar.
  - 2. Submit test reports for mortar materials and report proportions resulting from laboratory testing used to select mortar mix.
- B. Product Literature: The Contractor shall submit the manufacturer's product literature to the Architect for all proprietary products specified for repointing. Product literature shall include specification data, Material Safety Data Sheets, and instructions for storage, handling, and use.
- C. Historic Mortar Analysis: The Contractor shall submit the laboratory report from completed mortar analysis. Mortar analysis shall be completed prior to beginning test-panel preparation. At a minimum, analysis shall be a wet chemical and microscopic

analysis to characterize the insoluble aggregate, determine binder-aggregate ratio, prepare a mix design for replacement mortar, and identify appropriate sources for sand aggregate. If circumstances so dictate it, the Architect shall require the contractor to submit alternate mortar analyses, such as X-ray diffraction.

- D. Samples: No masonry restoration work shall proceed until all samples are approved by the Architect. The Contractor shall submit samples of the following masonry repair and replacement materials for approval of color and texture match:

Cured pointing mortar. Portable samples shall be prepared using drywall channel or similar material the approximate width of a mortar joint. Once a matching mortar color is achieved, placement of on-site mock-ups may begin.

#### 1.06 QUALITY ASSURANCE

- A. Work Experience: The Contractor and Masons to perform the work in this section shall have demonstrated experience approved by the Architect, ideally a minimum of ten (10) years experience with historic mortars and masonry repairs and repointing. He/she shall demonstrate a working knowledge of the Secretary of the Interior's Standards for Guidelines for Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings.
- B. The Contractor shall not change sources or manufacturers of mortar materials during the course of the work.

#### 1.07 MOCK-UPS

- A. The Contractor shall prepare two mock-up installations of each type of mortar color for each type of masonry to be installed at locations selected by the Architect. If cleaning tests are also to take place, test panels should be in the same area. Test panels should not be undertaken in areas that are highly visible.
- B. Each test panel shall be executed in the same manner as the final installation. Test panels shall be a minimum area of 3x3 feet for brick facades, and larger for stone facades.
- C. After the test panels have cured for a period of two to three weeks (or otherwise specified by the Architect), the test panels will be inspected for color, texture, and installation technique.
- D. If the Architect finds the first two mock-ups unacceptable, the Contractor shall prepare up to three additional mock-ups of each mortar and mortar color without further compensation. Test area(s) approved by the Architect shall become part of the work and shall serve as the quality standard for all subsequent work.

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall deliver all products to the site in original packaging, unopened and undamaged, with manufacturer's name and product identification visible thereon and manufacturer's instructions and Material Safety Data Sheets.
- B. The Contractor shall store products in a dry location and protect them from dampness and freezing following manufacturer's instructions.



- C. The Contractor shall stockpile and handle aggregates in a manner to prevent contamination from foreign materials.

#### 1.09 PROJECT / SITE CONDITIONS

- A. Mortar installation shall be executed only when the air and surface temperatures are 40 degrees F and rising or less than 80 degrees F and falling. Minimum temperature for masonry repointing shall be 50 degrees F and above for at least 2 hours after completion and above freezing for at least 24 hours after completion. Work shall not commence when rain, snow, or below-freezing temperatures are expected within the next 24 hours. All surfaces shall be free of standing water, frost, and ice.
- B. The Contractor is responsible for protecting existing adjacent materials and surfaces during the execution of the work, and will provide all necessary protection and follow all necessary work procedures to avoid damage to existing material assemblies not a part of the work in the Section.
- C. The Contractor shall provide visible barriers and / or warning tape around the perimeter of the work area for visitor protection, and shall also provide that nearby vehicles and adjacent structures and foliage are protected from damage during the course of the work.
- D. Contractor shall coordinate masonry repointing with the other trades involved in exterior and interior rehabilitation work, including but not limited to masonry cleaning, sealing, and painting.

### PART 2 - PRODUCTS

#### 2.01 MORTAR SELECTION CRITERIA: See Sections 04100.02 and 04400.01.

- A. Repair mortar shall be compatible with the material, quality, color, strength and texture of the existing mortar.
- B. Sand shall match the gradation of the historic mortar and be free from impurities. The color, size, and texture of the sand should be similar to the original sand.
- C. Mortar shall have greater vapor permeability and be softer, measured in compressive strength, than the masonry units.
- D. Mortar shall be as vapor permeable and be as soft or softer, measured in compressive strength, than the existing historic mortar.
- E. Testing and Mortar Selection for Masonry Units:
  - 1. Selection of Mortar for Brick Units:
    - a. Identify type and strength of brick.
    - b. Identify the composition, strength, and hardness of the historic mortar.
    - c. Lime and Sand mortars are preferred for historic brick masonry.

- d. Portland cement generally should not be used for historic brick, depending on historic resource.
  - e. Mortar should have a lower compressive (psi) strength than brick.
- 2. Selection of Mortar for Terra Cotta and Ceramic Units:
  - a. Mortar should have a lower compressive (psi) strength than the terra cotta and ceramic units.
  - b. Hard, portland cements or coarsely screened mortars shall not be used, depending on the historic resource.
- 3. Stone:
  - a. Identify type of stone.
  - b. Identify geological and mineralogical nature of stone.
  - c. Identify the Compressive or Crushing Strength of stone both wet and dry: ASTM C170-87 – Compressive Strength of Natural Building Stone.
  - d. Mortar should have a lower compressive (psi) strength than stone: general about 1/3 the compressive or crushing strength of the stone units.
  - e. Hard, portland cements are generally not appropriate for historic mortars, depending on the historic resource.
- 4. Concrete Block and Cast Stone Units:
  - a. Mortar should have a lower compressive (psi) strength than the masonry units.
  - b. Use of concrete amended mortars, when appropriate.

## 2.02 MORTAR TYPE AND MIX

- A. Depending on the desired strength and consistency, lime mortars should conform to ASTM C207 and ASTM C206, Mortar for Masonry, such as:
  - 1. Type M (2,500 psi): 3:1:12
  - 2. Type S (1,800 psi): 2:1:9
  - 3. Type N (750 psi): 1:1:6
  - 4. Type O (350 psi): 1:2:9
  - 5. Type K (75 psi): 1:3:11
  - 6. Type L: 0:1:3

OR

- B. Equivalent mortar that meets comparable federal specifications.

#### 2.03 POINTING MATERIALS AND MIXES (JOB-MIXED MORTAR)

- A. Portland cement: ASTM C150, Type I, non-staining and without air entrainment. Gray and white Portland cement may be combined as required to match the desired color.
  - 1. Non-staining white cement, preferred for historic applications, unless grey cement was used in the original mortar.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Lime Putty (slaked lime): should conform to ASTM C5.
- D. Sand: ASTM C144 Standard Specification for Aggregate for Masonry Mortar, free of clay, silt, soluble salts, and organic matter; shall match the color, size gradation, and texture of the original mortar sand. The Contractor may request from the Architect a sample of the original mortar sand, when available, for use in color and texture matching.
- E. Water: Potable, free from injurious amounts of oil, soluble salts, alkali, acids, organic impurities and other deleterious substances which impair mortar strength or bonding.
- F. Masonry Cement (premixed, bagged mortar): shall NOT be used.

#### 2.04 PRE-MIXED MORTARS: Pre-mixed mortars that have been designed for use on historic buildings may be used for repointing. All such mortars must be approved by the Architect.

#### 2.05 ACCESSORY MATERIALS

- A. Historic Materials include other components that enhance the color and texture matching and may include materials such as crushed oyster shells and animal hair, and historic pigments such as brick dust and lamp black.
- B. Colorants (if required for exact color match): Non-fading, mineral oxide masonry pigment as approved by the Architect.
  - 1. Pigments should not exceed 10% by weight of the portland cement in the mix.
  - 2. Carbon black should not exceed 2% of the Portland cement in the mix.

#### 2.06 ADMIXTURES

- A. No air-entraining admixtures or material containing air-entraining admixtures shall be added to the mortar.
- B. No antifreeze compounds shall be added to mortar.
- C. No admixtures containing chlorides shall be added to mortar.

#### 2.07 EQUIPMENT FOR MORTAR PREPARATION

- A. Equipment:

1. Trough, plastic buckets, hoe, wooden mallet, or similar implements
2. Mortar pan mill
3. Paddle or drum type mixers
4. Undyed, unprinted burlap

## **PART 3 – EXECUTION**

### **3.01 GENERAL**

- A. Testing and Mortar Selection shall be approved by the Architect. The Contractor shall submit testing schedule, mortar schedule, and schedule of related repairs, including methods and materials to be used:
  1. Identify masonry units: Type and composition.
  2. Identify the crushing or compressive strength (psi) of masonry units.
  3. Identify properties, composition, and strength of historic mortar.
  4. Select mortars that match the existing in color, texture, quality, and materials.
  5. Select mortars that are softer than the existing mortar and the masonry units.
- B. Mortar components should be measured and mixed carefully (in a consistent manner) to assure uniformity of visual and physical characteristics.
- C. Pre-mixed mortar should be mixed and handled following manufacturer's specifications.

### **3.02 FIELD MIXING FOR LIME MORTARS**

- A. Measure dry ingredients by volume.
- B. In a clean trough, wheelbarrow, or mixer (depending on quantities needed) combine and mix all dry ingredients thoroughly (before adding water).
- C. Add just enough clean water to "hold together," thus allowing the mixture to stand for a period prior to the addition of the remaining water.
- D. Prior to use, add half of the water and mix thoroughly for five (5) minutes.
- E. Add the remaining water in small portions until the desired consistency is reached. Keep the amount of water added to a minimum.
- F. Mortar should be used within approximately 30 minutes of final mixing. Do not retemper or add more water after final mixing.

### **3.03 FIELD MIXING FOR MORTAR USING LIME PUTTY**

- A. Materials are measured by volume.

- B. Do not add additional water.
- C. Proportion sand first, and then add the lime putty.
- D. Mix in a clean trough for five (5) minutes or until all the sand is thoroughly coated with the lime putty by beating with a wood mallet, interspersed by chopping with a hoe to achieve the maximum workability and performance.

OR

- E. Mix in a mortar pan mill when large quantities are needed, following the sequence above. Modern paddle and drum mixers do not achieve the desired results.
- F. Protect the mixture from the air by covering with wet burlap or seal in a large plastic bag.
- G. The sand/lime putty mix can be stored indefinitely if placed in a sealed bag or container. Recombine mixture as specified in D above into a workable plastic state. *Do not add water.*

3.04 FIELD MIXING FOR PORTLAND CEMENT –LIME PUTTY-SAND MORTARS  
(Type O or Type K)

- A. Materials are measured by volume.
- B. Combine sand and lime putty as described above and mix. Do not add water at this point.
- C. Mix the portland cement into a slurry paste using clean water.
- D. Combine the portland cement slurry with the sand/lime putty mixture.
- E. Add color pigments, if any.
- F. Mix for five (5) minutes.
- G. Mixture should be used within 30 minutes to 1 ½ hours. Do not retemper mixture. Once portland cement is added, the mortar can no longer be stored.

3.05 FINAL REPORT

The Contractor and Architect shall:

- A. Document the work, testing, and mortar mixes used, and finished product, including photographs (both ‘before’ and ‘after’) and final mortar schedules.
- B. Provide a written summary of the project and results upon final inspection and approval. The summary shall outline steps taken or new findings not specified in the initial documentation.

END OF SECTION



Historic Preservation - Technical Procedures

Spectitle: Monitoring And Evaluating Cracks In Masonry  
Procedure code: 0420002S  
Source: Hspg Prepared For Nps - Sero  
Division: Masonry  
Section: Unit Masonry  
Last Modified: 02/24/2012  
Details: Monitoring And Evaluating Cracks In Masonry

MONITORING AND EVALUATING CRACKS IN MASONRY

PART 1—GENERAL

1.01 SUMMARY

- A. This standard includes guidance on monitoring and evaluating cracks in masonry. Three different methods are described and include the following:
  - 1. Using tape and a pencil,
  - 2. Using glass and epoxy, and
  - 3. Using the Avongard Crack Monitor.
- B. Cracks in masonry are evidence that the building material has moved or is still moving, (active cracking).
- C. Some causes of cracking include: settlement or foundation erosion, decay of materials, "vandalism" by renovators, structural failure, change in materials or geometry, and moisture and temperature changes.
  - 1. In foundation piers and piles, general cracking is often due to settlement or rotation of the pier footing.
  - 2. Vertical cracking or bulging of a masonry foundation wall is often due to physical deterioration of the pier from exposure, poor construction or overstressing.
  - 3. Horizontal cracking or bowing of a masonry foundation wall may be caused by improper backfilling, or by swelling or freezing and heaving of water saturated soils adjacent to the wall.
  - 4. Differential settlement of a masonry foundation wall may be caused by many different things including soil consolidation, soil shrinkage, soil swelling, soil heaving, soil erosion or soil compaction.
  - 5. Differential settlement of a chimney is often caused by inadequate foundations which may cause the chimney to lean and crack.
- D. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
  - 1. Safety Precautions

2. Historic Structures Precautions
3. Submittals
4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling
8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

## PART 2—PRODUCTS

### 2.01 MANUFACTURERS

- A. Crack Monitor: Avongard, 2836 Osage, Waukegan, IL, 60087

### 2.02 EQUIPMENT

- A. A pencil, tape, ruler
- B. Small piece of window glass (single thickness) or glass slide
- C. Epoxy adhesive
- D. Crack monitor

## PART 3—EXECUTION

### 3.01 EXAMINATION

- A. Examine the nature and severity of the crack:
  1. What direction are the cracks going and where are they the widest?
  2. Note sloped floors, bulging walls and doors that do not fit.
- B. Determine the probable cause:
  1. Foundation erosion.
  2. Decay and/or improper use of materials.
  3. Structural failure.
  4. Change in materials or geometry.
  5. Changes in moisture content.
  6. Thermal changes:
    - a. Horizontal or diagonal cracks near the ground at piers in long walls: due to horizontal shearing stresses between the upper wall and the wall where it enters the ground,
    - b. Vertical cracks near the ends of walls,
    - c. Vertical cracks near the top and ends of the facade,
    - d. Cracks around stone sills or lintels: due to expansion of the masonry against both ends of the tight fitting stone piece that cannot be compressed.



### 3.02 ERECTION, INSTALLATION, APPLICATION

#### A. Monitoring Cracks Using Tape and Pencil:

1. Place a piece of tape on each side of the crack.
2. Draw one short line on each piece of tape at a convenient distance apart (2 inches) and parallel to the crack.
3. If there is movement in the crack, the distance between the line on the tape will vary; If the crack is long, several monitors will be needed.
4. Make a record chart of the distance between the marks of the tape at weekly intervals.
5. Keep accurate records of these measurements and place them along with photographs in file.
6. If significant widening occurs, report this with back-up data and copies of photographs to the RHPO for consideration.

#### B. Monitoring Cracks Using Glass and Epoxy:

1. Take a small piece of single strength window glass (a microscope slide is good) to bridge over the crack. Tiny glass rods are also made for this purpose.
2. Epoxy the ends of the glass to the masonry on either side of the crack; locate it in an inconspicuous place.
3. If the glass breaks, it is an indication that the walls are still moving and that the crack is widening.

#### C. Monitoring Cracks Using the Avongard Crack Monitor:

1. Position the monitor over the crack with the vertical "0" line on scale parallel with the crack to be measured.
2. Fix the monitor with screws or adhesive.
3. Cut the transparent tape holding the two plates of the scale on the monitor in a fixed position with a sharp knife; over time, the degree of movement on either side of the crack will be measured as the two plates slide independently of one another.

END OF SECTION

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#### Historic Preservation - Technical Procedures

Spectitle: Guidelines For Evaluating The Condition Of Brck Masonry & Mortar  
Procedure code: 0421109S  
Source: Developed For Hspg (Nps - Sero)  
Division: Masonry  
Section: Brick Unit Masonry  
Last Modified: 02/24/2012  
Details: Guidelines For Evaluating The Condition Of Brck Masonry & Mortar

#### GUIDELINES FOR EVALUATING THE CONDITION OF BRICK MASONRY AND MORTAR

CAUTION: THIS METHOD OF CONDITION ASSESSMENT IS DESTRUCTIVE AND SHOULD ONLY BE USED TO TEST AREAS BELIEVED TO BE DETERIORATED. THIS TEST SHOULD BE PERFORMED ONLY BY AN EXPERIENCED MASON.

This method of evaluation was developed by restoration architect Max Ferro and masonry conservator Tom Russack and appeared in the January/February 1987 issue of the old house journal.

#### \*\*\*MATERIALS\*\*\*

- Mason's hammer
- Cold chisel (1/2 to 1-1/2 inches)
- Sturdy slotted screwdriver

The deterioration of brick and mortar are evaluated by rating each on a scale from 0 to 10 based on their level hardness or softness. A rating of 0 indicates severe brick and/or mortar deterioration. A brief description of each rating follows.

#### \*\*\*ASSESSMENT OF BRICK\*\*\*

A rating of '4' or below indicates brick in an unsalvageable condition. A rating between '5' and '7' indicates that some remedial measures may need to be taken. A rating of '10' indicates that the brick units are in good, sound condition.

#### RATING DESCRIPTION

- |   |   |
|---|---|
| 0 | Bricks are totally disintegrated.   |
| 1 | Evidence of spalling at least 1/4" to 3" deep.  |
| 2 | Slight erosion at corners of brick; slight powdering of surface when rubbed with hand or scraped with fingernail.                     |
| 3 | Spalling brick in layers when rubbed with hand; fragments do not powder.  |
| 4 | Bricks can be broken by poking and jabbing with screwdriver; fragments are semi-hard and resemble compacted clay.                     |
| 5 | FIRST CLASS OF STABLE, STRUCTURALLY SOUND BRICK: Screwdriver can penetrate the brick by hand roughly 1/4" but brick does not crumble. |
| 6 | Screwdriver can penetrate the brick roughly 1/4", but   |

ONLY with the assistance of a hammer; this may cause coarse jagged pieces to become dislodged.

- 7 Screwdriver is unable to penetrate the brick even with assistance from hammer but may make a slight impression in the surface. There may be a slight ring or bounce as the screwdriver hits the surface.
- 8 Chisel is necessary to crack the brick.
- 9 Chisel is unable to make an indentation or impression in the brick; brick shears cleanly; brick is strong with crisp edges and corners.
- 10 A NEW BRICK: Brick with crisp corners; chisel striking the surface produces a clear ringing sound.

#### \*\*\*ASSESSMENT OF MORTAR\*\*\*

A rating between '0' and '4' indicates that repointing is necessary. A rating between '5' and '8' indicates mortar in satisfactory condition. A rating of '9' or '10', indicates that the mortar is too hard and should be replaced with a softer mortar.

#### RATING DESCRIPTION

- 0 No evidence of mortar within at least 1-1/2" of the wall face.
- 1 Mortar crumbles when poked with finger or screwdriver; many surface irregularities are evident.
- 2 Mortar is easily removed with screwdriver, but FEW surface irregularities are evident in joint.
- 3 Mortar collapses and freely and cleanly breaks adhesion with brick when scored along centerline with screwdriver.
- 4 Slight spalling occurs at edges and corners of brick when mortar is scored and tapped with screwdriver.
- 5 Screwdriver is unable to dislodge the mortar; chisel can disengage and pop mortar free without damaging the brick.
- 6 Edges and corners of brick are slightly marred when mortar is scored with a chisel.
- 7 Hammer AND chisel are necessary in order to disengage the mortar; there should be little damage to the brick.
- 8 Several blows with hammer and chisel are required to break the mortar into several large pieces; bricks will be noticeably marred.
- 9 MORTAR IS STRONGER THAN THE BRICKS: Successive blows with hammer and chisel crack brick.
- 10 MORTAR HAS HIGH PORTLAND CEMENT CONTENT: Successive blows with hammer and chisel pulverizes the brickwork.

END OF SECTION

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[Recovery.gov](http://Recovery.gov)



[Data.gov](http://Data.gov)



[USA.gov](http://USA.gov)



[Business.USA.gov](http://Business.USA.gov)



## Historic Preservation - Technical Procedures

Spectitle: Removing Biological Growth From Exterior Masonry And Stucco  
Procedure code: 0420002R  
Source: Hspg Prepared For Nps - Sero  
Division: Masonry  
Section: Unit Masonry  
Last Modified: 12/23/2014  
Details: Removing Biological Growth From Exterior Masonry And Stucco

### REMOVING BIOLOGICAL GROWTH FROM EXTERIOR MASONRY AND STUCCO

#### PART 1—GENERAL

##### 1.01 SUMMARY

- A. This procedure includes guidance on removing biological growth such as lichens, algae, mold and mildew from masonry and stucco.
- B. Biological growths such as lichens, algae, moss and fungi growing on masonry walls is usually an indication that there is excess moisture in or around the masonry. These growths should be removed, as they attract moisture to the masonry surface and hold it there, which can lead to more serious problems. Lichens and mosses in particular, produce oxalic acid which can damage certain types of historic masonry.
- C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
  - 1. Safety Precautions
  - 2. Historic Structures Precautions
  - 3. Submittals
  - 4. Quality Assurance
  - 5. Delivery, Storage and Handling
  - 6. Project/Site Conditions
  - 7. Sequencing and Scheduling
  - 8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

#### PART 2—PRODUCTS

##### 2.01 MANUFACTURERS

- A. ProSoCo, Inc.  
P.O. Box 1578  
Kansas City, KS 66117  
913/281-2700

## 2.02 MATERIALS

### A. For Removing Mold and Mildew:

1. Non-sudsing ammonia or one of the following bleaches:

CAUTION: DO NOT MIX AMMONIA WITH CHLORINE BLEACHES, A POISONOUS GAS WILL RESULT! DO NOT USE BLEACH ON BIRD DROPPINGS.

Sodium Hypochlorite (NaOCl):

- a. An unstable salt produced usually in aqueous solution and used as a bleaching and disinfecting agent.
- b. Other chemical or common names include Bleaching solution\*; Household bleach\*; Laundry bleach\*; Solution of chlorinated soda\*.
- c. Potential Hazards: CORROSIVE TO FLESH.
- d. Available from chemical supply house, grocery store or supermarket, hardware store or janitorial supply distributor.

-OR-

Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>):

- a. An unstable compound used especially as an oxidizing and bleaching agent, an antiseptic, and a propellant.
- b. Other chemical or common names include Peroxide of hydrogen\*; Solution of hydrogen dioxide\*; Superoxol\*; (hydrogen peroxide is commonly sold as a 3% solution; Superoxol is a 30% solution; Superoxol causes flesh burns; 3% hydrogen peroxide does not).
- c. Potential Hazards: TOXIC (when concentrated); CORROSIVE TO FLESH; FLAMMABLE (in high concentration).
- d. Available from chemical supply house, drugstore, pharmaceutical supply distributor, or hardware store.

-OR-

Calcium Hypochlorite (CaCl<sub>2</sub>O<sub>2</sub>):

- a. A white powder used especially as a bleaching agent and disinfectant.
- b. Other chemical or common names include Chlorinated calcium oxide; Bleaching powder\*; Calcium oxymuriate\*; Chloride of lime\*; Chlorinated lime\*; Hypochlorite of lime\*; Oxymuriate of lime\*.
- c. Potential Hazards: CORROSIVE TO FLESH; FLAMMABLE (WHEN IN CONTACT WITH ORGANIC SOLVENTS).
- d. Available from chemical supply house, dry cleaning supply distributor, drugstore or pharmaceutical supply distributor, janitorial supply distributor, swimming pool supply distributor, or water and sanitation supply distributor.

-OR-

Chloramine-T: Chloramine is any of various compounds containing nitrogen and chlorine.

## 2. Trisodium Phosphate:

NOTE: THIS CHEMICAL IS BANNED IN SOME STATES SUCH AS CALIFORNIA. REGULATORY INFORMATION AS WELL AS ALTERNATIVE OR EQUIVALENT CHEMICALS MAY BE REQUESTED FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA) REGIONAL OFFICE AND/OR THE STATE OFFICE OF ENVIRONMENTAL QUALITY.

- a. Strong base-type powdered cleaning material sold under brand names.
- b. Other chemical or common names include Sodium Orthophosphate; Tribasic sodium phosphate; Trisodium orthophosphate; TSP\*; Phosphate of soda\*; (also sold under brand names such as).
- c. Potential Hazards: CORROSIVE TO FLESH.
- d. Available from chemical supply house, grocery store or supermarket or hardware store.

## 3. Powdered detergent such as "Tide" or approved equal.

B. Proprietary cleaner such as "Limestone Restorer" (ProSoCo, Inc.), or approved equal.

C. Clean, potable water

## 2.03 EQUIPMENT

- A. Garden hose and nozzle
- B. Rubber or polyethylene bucket (DO NOT USE A METAL BUCKET AS IT MAY REACT WITH THE CHEMICAL CLEANER AND PRODUCE TOXIC FUMES)
- C. Glass or ceramic mixing bowl
- D. Knife blade
- E. Stiff, natural bristle brushes (non-metallic)
- F. Tampico brush, roller or low pressure (50 psi maximum) spray such as pneumatic garden sprayer
- G. Rubber gloves
- H. Safety glasses

## PART 3—EXECUTION

### 3.01 EXAMINATION

- A. Determine the source of excessive moisture, i.e. leaky downspout, standing water, roof overhang, vegetation, etc., and make any necessary repairs before continuing with this task.
- B. Determine the type of stain, i.e. algae and lichens, or mold and mildew.

### 3.02 PREPARATION

- A. Protection:
  1. Provide adequate wash solutions (i.e. water, soap and towels) before starting the job.
  2. Do not spray in the immediate vicinity of unprotected people and animals.

### 3.03 ERECTION, INSTALLATION, APPLICATION

NOTE: DO NOT TRY MORE THAN ONE TREATMENT ON A GIVEN AREA UNLESS THE CHEMICALS USED FROM PRIOR TREATMENT HAVE BEEN WASHED AWAY.

- A. Removing Lichens and Algae (ONLY):

1. Remove as much plant growth as possible using a knife blade and stiff bristle brush.
2. Water rinse the surface to remove most of the plant material.
  - a. If the substrate is sound and dense, use low to medium water pressure (100-400 psi).
  - b. If the masonry is softer, use standard water pressure from the spigot.
3. Allow water to soak plant growth for approximately 30 minutes.
4. Gently scrub the surface with a stiff, natural bristle brush.
5. Thoroughly rinse the surface again with clean, clear water at low pressure from a garden hose.

NOTE: DO NOT USE ANY CHEMICALS WITHOUT FIRST CONSULTING WITH RHPO.

B. Removing Mold and Mildew (ONLY):

CAUTION: DO NOT MIX AMMONIA WITH CHLORINE BLEACHES, A POISONOUS GAS WILL RESULT!

1. Mix the following:

3 oz. (2/3 cup) trisodium phosphate (TSP) cleaner  
 1 oz. (1/3 cup) powdered detergent (i.e. Tide)  
 1 qt. 5% sodium hypochlorite bleach (laundry bleach)  
 3 qts. warm water

-OR-

1 part ammonia with 3 parts water

2. Apply the solution to the affected area and scrub with a medium-hard natural bristle brush. Keep the surface saturated until the stain is bleached,

CAUTION: BE SURE TO WEAR RUBBER GLOVES AND SAFETY GLASSES WHEN APPLYING THE SOLUTION.

3. Thoroughly rinse the surface with clean, clear water from a garden hose and allow to dry.
4. Repeat the process as necessary to achieve the desired level of cleanliness.

-OR-

C. For treating any of the above (lichens, algae, mold or mildew), try using a proprietary cleaner such as Limestone Restorer (ProSoCo, Inc.), or approved equal.

1. Add 1 part Limestone Restorer to 3 parts water and mix in a rubber or polyethylene bucket.
2. Apply a flood coat of this mixture to the masonry using a low pressure spray (approximately 50 psi).

CAUTION: DO NOT USE A HIGH PRESSURE SPRAY WHEN APPLYING THIS SOLUTION AS THIS MAY CAUSE THE SOLUTION TO BE DRIVEN DEEPER INTO THE PORES OF THE MASONRY, MAKING REMOVAL OF THE SOLUTION DIFFICULT.

- a. Begin spraying at the top of the vertical surface and move across horizontally. Allow 100mm rundown.
- b. Continue the next horizontal pass across the previous run down.
- c. Allow the solution to remain on the surface



approximately 5-30 minutes depending upon the thickness of the growth.

- d. Gently scrub the surface with a stiff, natural bristle brush.
- e. Thoroughly rinse the treated area using pressure-applied water (approximately 400 to 1500 psi) with a 40-60 degree fan spray or garden hose with nozzle adjusted to a tight stream. Rinse from the bottom of the treated area to the top.
- f. Allow the surface to dry a minimum of 24 hours.

END OF SECTION

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*Last Reviewed 2014-12-23*

**PART 1 - GENERAL**

## 1.01 DESCRIPTION

- A. This specification provides guidance for replicating wood period objects.
- B. This specification has been developed for use on historic properties (defined as any district, site, building, structure, or object that is listed in or eligible for listing in the National Register of Historic Places) and provides an overview of accepted practices. Site-specific specifications, when appropriate, will be provided by the Architect.
- C. All work described herein and related work must conform to the Secretary of Interior's Standards for the Treatment of Historic Properties.
- D. The Contractor shall provide all labor, materials, equipment, and operations required to complete the rehabilitation work indicated herein.
- E. All work described herein and related work must have the approval of a Cultural Resources Manager, Conservator, Historic Architect, or other professional who meets the standards outlined in the Secretary of the Interior's Standards – Professional Qualifications Standards pursuant to 36 CFR 61. Such person is referred to in this document as the *Architect*.

## 1.02 SECTION INCLUDES

- A. Measurement and Replication of Existing Objects
- B. Fabrication of Object (shutters, columns, column capitals, etc.)

## 1.03 RELATED SECTIONS

- A. Section 06200.02 – Wood Properties and Appropriate Lumber
- B. Section 06220.01 – Replication of Period Profiles

## 1.04 REFERENCES

- A. Work shall conform to: Weeks, Kay D. and Anne E. Grimmer. *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*. Washington D.C.: NPS, 1995. 30 July 2009 <[http://www.nps.gov/history/hps/tps/standards\\_guidelines.htm](http://www.nps.gov/history/hps/tps/standards_guidelines.htm)>.

- B. As applicable, techniques employed shall adhere to following guideline:  
Myers, John H. *Preservation Brief No. 9: The Repair of Historic Wooden Windows*. Washington D.C.: TPS 1981. 31 July 2009. <<http://www.nps.gov/history/hps/tps/briefs/brief09.htm>>. *Historic Preservation Technical Procedures Standards for Historic Exterior Wood*. General Services Administration, 2009. 30 July 2009. <<http://w3.gsa.gov/web/p/hptp.nsf>>.
- C. Architectural Woodwork Institute. *Architectural Woodwork Quality Standards*. 8th ed. Reston: Arch. Woodwork Institute, 2005.
- D. Hull, Brent. *Historic Millwork: A Guide to Restoring and Re-creating Doors, Windows, and Moldings of the Late Nineteenth through Mid-Twentieth Centuries*. Hoboken: John Wiley & Sons, Inc., 2003.
- E. National Park Service. *HABS Guidelines: Recording Historic Structures and Sites with HABS Measured Drawings*. Ed. John A. Burns. Washington D.C.: NPS, 2005. 31 July 2009 < [http://www.nps.gov/hdp/standards/HABS/graphics/HABS\\_DWGS\\_GUIDE\\_2005.pdf](http://www.nps.gov/hdp/standards/HABS/graphics/HABS_DWGS_GUIDE_2005.pdf)>

#### 1.05 SUBMITTALS

- A. Repair Schedule: Submit a detailed schedule of objects to be replicated including procedures for removal of deteriorated features, measuring of existing objects and fabrication of new objects. Coordinate all necessary removal, fabrication, delivery and installation work with the general contractor and other applicable trades. The extent of replacement is subject to Architect approval.
- B. Shop Drawings: The Contractor shall submit shop drawings for all new millwork required for the project. Shop drawings shall show dimensions, include full-size details as necessary, and be in conformance with the *Architectural Woodwork Quality Standards* (Eighth ed. Vers. 2) guidelines for architectural millwork shop drawings. Wood species shall be clearly indicated.
- C. Samples: The Contractor shall one sample of each type of wood object to be fabricated (scale to be determined by Architect). Samples are of the same species to be used in the work. If full-size, approved sample may be used in preparation of required mock-ups.
- D. Product Literature: Submit manufacturer's product literature to architect for all proprietary products specified. Product literature shall include specification data, Material Safety Data Sheets and instructions for storage, handling and use.

#### 1.06 QUALITY ASSURANCE

- A. Work Experience: The Contractor shall have demonstrated experience approved by the Architect, ideally a minimum of seven years experience in the production of custom architectural millwork and the replication of period objects and shall have successfully completed at least three projects of similar scope within the previous five years. He/she shall demonstrate a working knowledge of *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*.
- B. Warranty: Ten (10) year warranty on materials and workmanship for replicated wood objects.

#### 1.07 MOCK-UPS

- A. Procedure: Prior to start of wood replication work, prepare one mock-up for each type of wood object (shutter, column, column capital, etc.) indicated to be replaced. Prepare mock-up panels on existing woodwork to demonstrate quality of materials and workmanship. Obtain supervising Architect's acceptance of visual qualities before proceeding with the work. Retain acceptable panels in undisturbed condition, suitably marked, during construction as a standard for judging completed work.
- B. More than one mock-up may be required to be acceptable for approval. The Contractor shall prepare at least three mock-ups of each type (moveable and fixed), if necessary, without further compensation. The approved mock-up shall become part of the work and shall serve as the quality standard for all similar work.

#### 1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver restoration materials to the project site in manufacturer's or distributor's packaging, undamaged, complete with instructions and Material Safety Data Sheets as applicable. Store any required fillers, putties and adhesives within the temperature range recommended by the manufacturer and away from direct sunlight.
- B. Deliver all materials only when the project is ready for installation and the general contractor has provided a clean storage area as defined in the Architectural Woodwork Quality Standards as adopted by the Architectural Woodwork Institute (AWI). Coordinate deliveries of new millwork and restoration of existing millwork to avoid delays in the project. Coordinate storage of new materials at the site with the Owner's representative. Allow adequate notice to Owner's representative of scheduled millwork deliveries.
- C. Fabricated wood objects shall be delivered to the site in crates or other sturdy packaging to prevent loss and damage. Store all wood fabrications indoors in a dry, secure location above grade, protected from moisture and with adequate ventilation, until ready for installation. Store off the ground on pallets or dunnage.
- D. Allow new woodwork to acclimate at least one week to ambient temperature and humidity prior to installing.

#### 1.09 PROJECT / SITE CONDITIONS

- A. The Contractor is responsible for protecting existing adjacent materials during the execution of the work. Provide all necessary protection and work procedures to avoid damage to existing material assemblies not a part of the work of this Section.
- B. All completed work shall be adequately protected from damage by subsequent building operations and effects of weather. Protection shall be by methods recommended by the manufacturer of installed materials and as approved by the supervising Architect.
- C. Maintain temperature and relative humidity during fabrication, storage and finishing operations so that moisture content values for woodwork at time of installation do not exceed the specified range.

- D. The Contractor shall be responsible for disposal of waste materials and other debris associated with the work of this Section in accordance with local, state and federal environmental regulations.
- E. The Contractor shall coordinate the fabrication and delivery of new wood objects with other trades including, but not necessarily limited to, carpentry, plaster and painting to avoid delays in the project.

## **PART 2 – PRODUCTS**

### **2.01 MEASUREMENT OF EXISTING OBJECT**

Equipment to document size and shape of object:

- A. Measuring tape
- B. Bevel square
- C. Profile gauges
- D. Pencil and paper (for tracings and rubbings)
- E. Camera and tripod
- F. Flashlight
- G. Calipers
- H. Dividers
- I. Carpenter's squares
- J. Compasses
- K. Templates and curves

### **2.02 FABRICATION OF NEW WOOD OBJECTS**

- A. General: Where possible, existing historic wood elements should be retained and repaired. Where replacement is required due to the nature or extent of deterioration, replicated wood objects should be as close as possible to the original in size, shape, detail and finish. Accurate measurement of the existing object, as well as a thorough investigation into its component materials and finishes, is essential. A true "in kind" replacement will also match new material to old with regards to species, quality (e.g. first vs. second growth), cut (e.g. quarter sawn vs. flat sawn), grain direction and pattern, and even tool marks.

Selection of Wood: Wood for in-kind replacement should be selected based on the material it is replacing and the qualities outlined in Section 06200.02, Wood Properties and Appropriate Lumber.

- B. Wood Materials
  - 1. New exterior woodwork to be painted shall be constructed of a durable wood suitable for outdoor paint finishes and approved by the Architect.
  - 2. New exterior woodwork for transparent finish shall match the species, cut, grain direction and pattern of the existing or historic woodwork. Match grade if known.

3. Moisture content:
  - a. Not to exceed 12 percent for trim and millwork that is 1¼ inch or less in thickness.
  - b. Not to exceed 15 percent for trim and millwork four inches or fewer in thickness.
4. Grading:
  - a. NHPMA Official Grading Rules, 1978: All species, C and better Select.
  - b. WWPA Standard Grading Rules, 1988: All species C Select except Choice for Idaho White Pine.
  - c. WCLIB Standard Grading and Dressing Rules, 1984: All species, C and better VG.
  - d. NHLA Grading Rules, First Grade unless otherwise indicated.
  - e. NELMA Grading Rules, 2006, Select Grade D or better.

## **PART 3 – EXECUTION**

### **3.01 GENERAL**

Quality Standard: Unless otherwise indicated, comply with AWI *Architectural Woodwork Quality Standards* for grades of architectural woodwork, construction, finishes and other requirements.

### **3.02 MEASUREMENT OF EXISTING OBJECTS**

- A. General: The purpose of replicating existing historic wood objects is to allow in-kind replacement of damaged, deteriorated or missing woodwork per Section 06400.01, Historic Wood In Kind Replacement. In most instances, replication of wood objects will be outsourced to a qualified millwright or cabinet shop that is already in possession of a shaper knives, lathe patterns, etc. to accommodate a variety of period objects. Before custom fabrication is undertaken, a variety of sources and pattern books for historic objects should be consulted to determine if a stock replacement is available.
- B. Measuring and Drawing Existing Objects:
  1. Establish accurate horizontal and vertical datum lines before measuring.
  2. If possible, compensate for paint layers that tend to obscure the sharpness of detail. Where accumulated paint layers make it difficult to obtain an accurate measurement of an existing profile, carefully remove paint in consultation with supervising Architect.
  3. Select a recording instrument suitable for size and complexity of object to be replicated, e.g. profile gauge, calipers, carpenter's square. Tracings, pencil rubbings, photographs, or the use of a flashlight to provide raking light can also be helpful.
  4. Calipers, dividers and carpenter's squares are useful in measuring objects that are round in cross-section, such as balusters, decorative urns and spheres, and columns.

5. When determining column diameters, care must be taken to account for entasis-- the slight convex curvature of the vertical profile of the column - if it is present. Note: In Roman entasis, for example, curvature begins at 1/3 the distance from the bottom of the base to the top of the capital; in Greek entasis, curvature begins at the base. Field notes and detail drawings should reference heights from the base at which diameters were determined.
6. Record dimensions to the 1/8th, 1/16th or 1/32 of an inch depending on size of object and level of detail.
7. Translate measurements into elevation and section drawings with numbered or lettered details. Details are typically drawn at 1- 1/2'=1'-0" or larger. AutoCAD drawings are helpful because of the possibility for infinite scale views.

### 3.03 FABRICATION OF OBJECT

General: Replicated wood objects should mimic the original in size, shape, detail, color, and finish. Accurate measurement of the existing object, as well as a thorough investigation into its component materials and finishes, is essential. A true "in kind" replacement will also match new material to old with regards to species, quality (e.g. first vs. second growth), cut (e.g. quarter sawn vs. flat sawn), grain direction and pattern, and even tool marks.

Selection of Wood: Wood for in-kind replacement should be selected based on the material it is replacing and the qualities outlined in Section 06200.02, Wood Properties and Appropriate Lumber.

#### A. Procedure:

1. Contractor shall provide shop drawings of all millwork for review by the Architect. The Contractor (or subcontractor, if outsourcing fabrication) shall not begin fabrication of said millwork until shop drawings have been released and submitted samples have been approved.
2. Shop drawings must indicate the physical dimensions and details or profiles of all elements of the work, including the location of different grades, species, and/or finishes.
3. As an additional record of repairs, all replicated wood shall be date stamped on the back prior to installation.
4. All objects to be fabricated to American Woodwork Quality Standards. Custom, Premium, or Economy grades are to be specified in Scope of Work and/or clarified by supervising Architect.
5. It is the responsibility of the millwork fabricator to observe the project before bid and match all materials for species, grain and overall appearance. The profiles and details of all millwork shall match existing or shall be as detailed on the contract drawings and the approved shop drawings.
6. Fabricate custom millwork in maximum practical lengths to minimize joints. Prepare all work for delivery to the site in lengths suitable for passage through the building interior.



7. Where practicable, the shop assembles and finishes items of built-up millwork. When it is necessary to cut and fit on-site, provide materials with ample allowance for cutting. Provide adequate material stock for scribing and site cutting.
  8. All glue joints shall be glued under pressure using Type 1 waterproof glue and allowed to cure for a minimum of 24 hours.
  9. Machine-sand exposed flat members and square edges. Machine-finish semi-exposed surfaces.
  10. For painted surfaces: All custom millwork that is to be painted shall be primed with two coats of primer and hand sanded between coats. Back prime all concealed surfaces of exterior trim. Exterior columns shall be coated on the interior with an appropriate weather fast paint.
- 3.04 FINAL REPORT: After completion of the replication work, the Contractor shall submit a final report including copies of approved submittals, initial assessment of existing historic wood and determination of objects to be replaced (itemized by type and location, identifying characteristics including wood species and extent/type of deterioration), photographs taken during measurement of existing profiles and during and after fabrication of new objects, and a written description of the executed work.

END OF SECTION

**PART 1 - GENERAL****1.01 DESCRIPTION**

- A. This specification provides guidance for installation of wood shingles and copper flashings.
- B. This specification has been developed for the Matthew Jones House. The Matthew Jones House is a significant historic structure. All work shall be completed in such a way as to protect existing architectural features from damage and to retain as much historic fabric as possible, with a minimum of loss.
- C. All work described herein and related work must conform to the Secretary of Interior's Standards for the Treatment of Historic Properties.
- D. The Contractor shall provide all labor, materials, equipment, and operations required to complete the work indicated herein.
- E. All work described herein and related work must have the approval of a Cultural Resources Manager, Conservator, Historic Architect, or other professional who meets the standards outlined in the Secretary of the Interior's Standards – Professional Qualifications Standards pursuant to 36 CFR 61. Such person is referred to in this document as the *Architect*.

**1.02 SECTION INCLUDES**

- A. Installation of Wood Shingles
- B. Fabrication and Installation of Flashing

[NOTE: Repairs to roof sheathing and repair/replacement of exterior trim work are related but not included here. This carpentry work should be completed after roofing contractor has removed existing roof covering and salvaged materials.]

**1.03 RELATED SECTIONS**

- A. Section 06200 – Fasteners for Historic Exterior Wood
- B. Section 07631 – Flashing, Gutters and Drains

## 1.04 REFERENCES

- A. *Historic Preservation Technical Procedures: All Procedures- 06 Wood and Plastics*. General Services Administration. 2009. 2 July 2009 <  
[http://w3.gsa.gov/web/p/hptp.nsf/  
All%20Procedures?OpenView&Start=1&Count=30&Expand=6#6](http://w3.gsa.gov/web/p/hptp.nsf/All%20Procedures?OpenView&Start=1&Count=30&Expand=6#6)>.
- B. Treatment shall conform to:
  - 1. *The Secretary of the Interior's Standard's for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*. Washington D.C.: National Park Service, 1995. 30 July 2009 .  
<[http://www.nps.gov/history/hps/tps/standards\\_guidelines.htm](http://www.nps.gov/history/hps/tps/standards_guidelines.htm)>.
  - 2. Park, Sharon C. *Preservation Brief No. 19, The Repair and Replacement of Historic Wood Shingle Roofs*. Washington D.C.: National Park Service, 1989. 6 August 2009. <<http://www.nps.gov/history/hps/tps/briefs/brief19.htm>>.
- C. Cedar Shake and Shingle Bureau. *New Roof Construction Manual*. The Cedar Shake and Shingle Bureau, 2015. 17 July 2015. <<http://www.cedarbureau.org/installation-and-maintenance/roof-manual/>>.
- D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA). *Architectural Sheet Metal Manual*. 7th Edition. SMACNA, 2012.
- E. Copper Development Association. *Copper in Architecture - Design Handbook*. 21 July 2015. <[http://www.copper.org/applications/architecture/arch\\_dhb/](http://www.copper.org/applications/architecture/arch_dhb/)>.

## 1.05 SUBMITTALS

The Contractor shall submit to the Architect:

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- B. Samples: Submit three samples of roof shingles from multiple material bundles. Submit one sample each of the following: all fasteners, lead-coated copper flashing. Samples shall be the same size, texture and color as those to be used for the work.

## 1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 5 years experience manufacturing similar products.
- B. Installer Qualifications: The Contractor to perform the work in this section shall have demonstrated experience approved by the Architect, ideally a minimum of 7 years experience in historic roof replacement/restoration and shall have successfully completed at least three projects of similar scope within the previous five years. He/She shall demonstrate a working knowledge of *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*.
- C. Warranty: The Contractor shall provide the roof shingle manufacturer's warranty for material plus provide an additional five-year warranty against deterioration due to installation issues.

## 1.07 MOCK-UPS

In the presence of the Architect, all personnel to be assigned to the project shall demonstrate their ability to complete the required work in an acceptable manner. The process of determining contractor ability will be left to the discretion of the Architect based on the specific technical needs of the project. The Contractor must demonstrate a comprehensive understanding of the unique skills needed during the installation of new wood shingles and recreation of historic roof details.

## 1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the site in manufacturer's unopened bundles with the manufacturer's labels intact and product identification visible.
- B. Wood materials delivered to the site shall be stored on pallets or dunnage above grade in such a manner as to allow adequate air circulation. Stored materials shall be protected from the weather using tarpaulins or similar waterproof membrane.
- C. The Contractor shall dispose of all packaging, waste materials and construction debris in accordance with local, state and federal environmental regulations. All wood scrap shall be kept separate for recycling. No burning of debris, waste material or trash will be allowed on site.

## 1.09 PROJECT/SITE CONDITIONS

- A. The Contractor is responsible for protecting existing adjacent materials during the execution of the work. Provide all necessary protection and work procedures to avoid damage to existing material assemblies not a part of the work of this Section. At a minimum, the Contractor shall:

1. Provide sturdy, weather-proof protection at all areas exposed during shingle installation. Do not leave interior spaces exposed to the elements overnight. The Contractor shall maintain adequate supplies of protective materials on site at all times in the event of sudden weather changes.
  2. Protect roof framing during shingle installation by limiting imposed loads.
- B. Provide barriers around the work area to protect other trades and the public. At least one entrance must remain accessible during the course of the work.
- C. The Contractor shall coordinate roofing work with the work of other trades to minimize delays in the construction process. Coordinate roofing with other work including, but not limited to, exterior finish carpentry, flashing work and masonry restoration.

## **PART 2 - PRODUCTS**

### **2.01 SHINGLES**

- A. Shingles shall be of [SELECT ONE: white oak, Atlantic white cedar, Certi-Sawn Tapersawn Number 1 Alaskan yellow cedar shakes], premium (select) grade or better, and cut from 100% heartwood. No splits, cracks, knots or other defects in shingles permitted. Shingles shall be taper sawn and have a square butt end.
- B. Shingles shall measure 16 inches in length and shall be of widths varying from no less than 4 inches to no more than 8 inches. Butt-end thickness shall be no less than  $\frac{5}{8}$  inches, tapering to +/- 1/16 inches.

[NOTE: If Certi-Sawn yellow cedar shakes are selected, the following option is available.]

- C. Shingles shall be pressure impregnated with fire retardant treatment (e.g. Certi-Guard).

### **2.02 FASTENERS**

- A. Copper roofing nails, smooth shank.
- B. Stainless steel Type 316 roofing nails, smooth shank.
- C. 8d Lead head nails
- D. Fasteners shall be long enough to penetrate into the solid wood sheathing at least 3/4 inches or all the way through.

## 2.03 FLASHING AND UNDERLAYMENT

- A. 36 inch wide, 30 pound asphalt saturated roofing felt
- B. 16 ounce lead-coated copper flashing
- C. Red rosin paper
- D. Lead wool

## 2.04 MANUFACTURERS

### A. Shingles

1. Jack Abeel [for white oak, Atlantic white cedar]  
Disputanta, VA  
(804) 856-1561
2. Shamokin Trail Shingle Co. [for white oak, Atlantic white cedar]  
Luthersburg, PA  
(814) 583-5342
3. Tarheel Shingle Mill [for white oak, Atlantic white cedar]  
513 Old Mill Road  
High Point, NC 27265  
(336) 841-7440
4. Museum Resources [for white oak, Atlantic white cedar]  
P.O. Box 911  
Williamsburg, VA, 23187-911  
(804) 966-1800
5. Gates Custom Milling, Inc. [for white oak, Atlantic white cedar]  
PO Box 405 Rt. 37  
Gatesville, NC 27938  
(800) 682-9663
6. [NOTE: for 16 inch “Fivex” Alaskan yellow cedar shingle manufacturers, see listing provided by Cedar Shake and Shingle Bureau at  
<[http://www.cedarbureau.org/purchasing/-result-by-category.asp?prodcategory=CERTIGRADE%20SHINGLES#16-inch Fivex Shingles](http://www.cedarbureau.org/purchasing/-result-by-category.asp?prodcategory=CERTIGRADE%20SHINGLES#16-inch+Fivex+Shingles)>]

### B. Fasteners

1. Simpson Strong-Tie  
<http://www.strongtie.com/>

2. Grip-Rite  
www.grip-rite.com  
(800) 676-7777

C. Flashing

1. Old World Distributor, Inc.  
<http://www.oldworlddistributors.com/>  
(269) 372-3916
2. B & B Sheetmetal  
<http://www.bbsheetmetal.com/>  
25-40 50th Ave.  
Long Island City, NY 11101  
(718) 433-2501
3. Riverside Sheet Metal  
<http://www.riversidesheetmetal.net/>  
Metal 15 Reardon Road  
Medford, MA  
(781) 396-0070

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. The Contractor shall review the scope of work and the site conditions with the Architect prior to beginning operations. Any conditions that may adversely impact the proper completion of the work shall be brought to the attention of the owner and the Architect.
- B. All personnel working on the roof shall wear soft-soled shoes.
- C. When working off ladders or other platforms, avoid point loading on the wood shingle roofing by providing plywood or other rigid materials where necessary under ladders.
- D. Roof deck surfaces shall be smooth, clean, firm, dry, and free from loose boards, large cracks, and projecting ends that might damage the roofing. Foreign particles shall be cleaned from interlocking areas to ensure proper seating and to prevent water damming.

### **3.02 FLASHING AND UNDERLAYMENT**

A. Underlayment

1. Rake lines, eaves, and valleys shall be covered with 36 inch wide, 30 pound asphalt saturated roofing felt prior to the installation of flashing.

2. Ridges shall not be covered with roofing felt.
  3. Red rosin paper slip sheeting shall be installed over asphalt saturated felt at eaves, rake lines and valleys.
- B. Existing sheet metal elements that are intact and serviceable shall be salvaged and reused whenever possible. When work involves repair and replacement of copper sheet metal elements, new elements shall match existing original elements as closely as possible. [NOTE: Modify this if budget exists for new metal.]
- C. Flashing shall be fabricated using 16 ounce lead-coated-copper and fastened using copper nails, except where stated. Fabricate flashing in the longest sections possible to minimize joints.
- D. Flashing joints shall have a minimum 4 inch overlap to form continuous waterproof system.
- E. Eaves and Rake Lines
1. Drip-edge flashing shall be installed at all eaves, extending 6 inches up the roof and turned down ½ inch onto the fascia.
  2. Drip-edge flashing shall be installed at all rake lines (at gable ends), extending 4 inches onto the roof and turned down ½ inch onto the rake board.
- F. Valleys
1. Valleys shall be flashed using an 18 inch wide flashing with a 1 inch high ridge through the center.
  2. A 6 inch exposure shall be used to duplicate the exposure of the existing valleys.
- G. Chimney
1. The chimney of the rear chamber shall be step-flashed and secured in mortar joints with lead wool caulking. Details shall match existing.
- H. Wall Intersection at Shed Roof
1. The juncture between the rear shed roof and the main structure shall be flashed using 4 foot long sections of flashing overlapped 6 inches and secured in mortar joints with lead wool caulking (reglet). Details shall match exiting.
- I. Rain Diverter
1. A horizontal rain diverter shall be installed above the first course of shingles on the shed roof directly above, and extending 6 inches beyond, the cellar doors.



2. Rain diverter shall extend a minimum of 4 inches up the roof with the exposed end turned up 1½ inches and turned back to form a double-thickness ledge.

J. Ridge Cap

1. A ridge cap shall be manufactured from lead-coated copper with details replicating those of the existing ridge cap.
2. Installation details shall match existing.
3. Ridge cap shall be fastened using 8d lead head nails.

### 3.03 ROOFING COVERING

- A. Shingles wider than 8 inches shall be split in two before nailing.
- B. Shingles shall be doubled at all eaves.
- C. Butts of the shingles in the first course on roofs shall project 1½ inches from the edge of roof eaves. Shingles shall project 1¼ inches at gable and rake edge.
- D. Shingles shall be spaced apart not less than 1/4 inch, not more than 3/8 inches
- E. Shingles shall be laid with a side lap not less than 1 ½ inches between joints in adjacent courses, and not more than 10% shall be in direct alignment in alternate courses.
- F. Shingles course shall be laid with a 4½ inches exposure. Courses shall be laid with slightly less exposure as needed to maintain a minimum of 4 inches exposure. A finish course of shingles shall be trimmed in length to maintain minimum exposure.
- G. Each roof shingle shall be secured with two full-driven stainless steel nails. Contractor shall secure shingles using copper nails when nailing through flashing.
- H. Nails shall be driven flush but not so that the nail head crushes the wood. They shall be placed approximately ¾ inches to 1 inch from the side edges of the shakes/shingles and approximately 1 1/2 inches above the butt line of the following course.
- I. Cut-off or clinch all nail ends penetrating through the underside of sheathing on the shed roof.

### 3.04 FINAL REPORT

Provide a final report of completed work including all approved submittals and photographs of roofing and flashing details taken before, during and after the work.

END OF SECTION

## SECTION 09910.03 CLEANING, PREPARATION AND REPAINTING OF EXTERIOR WOOD SURFACES

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### PART 1 - GENERAL

#### 1.01 DESCRIPTION

- A. This specification provides guidance for surface preparation and repainting of wood.
- B. This specification has been developed for use on historic properties (defined as any district, site, building, structure, or object that is listed in or eligible for listing in the National Register of Historic Places) and provides an overview of accepted practices. The Architect will provide site-specific specifications, when appropriate.
- C. All work described herein and related work must conform to the Secretary of Interior's Standards for the Treatment of Historic Properties.
- D. The Contractor shall provide all labor, materials, equipment, and operations required to complete the rehabilitation work indicated herein.
- E. All work described herein and related work must have the approval of a Cultural Resources Manager, Conservator, Historic Architect, or other professional who meets the standards outlined in the Secretary of the Interior's Standards – Professional Qualifications Standards pursuant to 36 CFR 61. Such person is referred to in this document as the *Architect*.

#### 1.02 SECTION INCLUDES

- A. Preparation of Wood Surfaces for Painting
- B. Application of Paints to Wood Surfaces

#### 1.03 RELATED SECTIONS

- A. 06200.02 – Wood Properties and Appropriate Lumber
- B. 06300.01 – Cleaning and Testing of Atmospheric Soiling, Biogrowth and Mold
- C. 07900.01 – Joint Sealer Properties and Application
- D. 09910.04 – Cleaning and Testing of Atmospheric Soiling on Painted Surfaces

#### 1.04 REFERENCES

- A. Work shall conform to *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*. Washington D.C.: National Park Service, 1995. 6 August 2009. <[http://www.nps.gov/history/hps/tps/standards\\_guidelines.htm](http://www.nps.gov/history/hps/tps/standards_guidelines.htm)>.

- B. Look, David W. and Weeks, Kay D. *Preservation Brief No. 10: Exterior Paint Problems on Historic Woodwork*. Washington D.C.: National Park Service, 1982. 6 August 2009. < <http://www.nps.gov/history/hps/tps/briefs/brief01.htm>>.
- C. Hicks, Douglas C. and Park, Sharon C. *Preservation Brief No. 37: Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing*. Washington D.C.: National Park Service, 1995. 6 August 2009.< <http://www.nps.gov/history/hps/tps/briefs/brief37.htm>>.
- D. *Historic Preservation Technical Procedures: All Procedures- 04 Historic Masonry and 09 Historic Finishes*. General Services Administration. 2009. 2 July 2009 < <http://w3.gsa.gov/web/p/hptp.nsf/All%20Procedures?OpenView> >.
- E. Painting and Decorating Contractors of America. *PDCA Industry Standards*. Latest Edition.

#### 1.05 SUBMITTALS

- A. Submit a detailed schedule to architect for approval of work under this section, including an assessment of the problem areas and a historic paint analysis.
- B. Testing: Provide paint analysis to determine appropriate paint colors for the restoration period and paint composition, as appropriate. Paint color shall be matched to a manufacturer's standard color if available or provided in the form of a notation in a standardized color system such as CIE L\*a\*b\* that can be duplicated by a paint manufacturer. Munsell notations are not acceptable. This work must be performed by a qualified architectural conservator specializing in analysis of historic paints and finishes.
- C. Product Literature: Submit manufacturer's product literature to architect for all manufactured products specified for paint work. Product literature shall include specification data, Material Safety Data Sheets and instructions for storage, handling and use.
- D. Samples: The Contractor shall submit samples of the following paint materials for approval of color match and texture match. No work shall proceed until all samples are approved.
  - 1. Color samples: Prepare at least three portable samples approximately 6x6 inches of each standard and custom color as identified by the historic paint analysis. Once a matching paint color is achieved, placement of on-site mock-ups may begin.
  - 2. Drawdown samples: Once a paint supplier has been determined for the project, provide drawdown samples (6x6 inches minimum) of the actual paint to be used on the project for comparison with previously approved samples. Provide one drawdown sample for each color/gloss to be used on the project.

#### 1.05 QUALITY ASSURANCE

- A. Work Experience: The Contractor to perform the work in this section shall have demonstrated experience approved by the Architect, ideally a minimum of seven years experience working on projects relating to the analysis, preparation and application of historic paint finishes and shall have successfully completed at least three projects of similar scope within the previous five years. He/She shall demonstrate a working knowledge of *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*.

- B. The Contractor shall not change source or manufacturer of paint materials during the course of the work.
- C. Warranty: Installer shall provide a warranty, in writing, against defects in material and installation for a period of five years after substantial completion of the work to make immediate repairs as required to correct defects in the work regardless of the nature of the defect, except repairs required due to abuse, alterations or failure of the substrate.

#### 1.06 MOCK-UPS

- A. After selection of a paint color from the portable samples, the Contractor shall prepare one mock-up installation for each color to be installed at locations selected by the Architect. If cleaning tests are also to take place, test panels should in the same area. Test panels should not be undertaken in areas that are not highly visible. Each test panel shall be executed in the same manner as the final installation. Test panels shall be a minimum area 3x3 ft. Test panels will be inspected for color and application technique.
- B. The Contractor shall prepare up to three additional mock-ups of each paint color at no additional cost without further compensation. Approved test area(s) shall become part of the work and shall serve as the quality standard for all subsequent work.
- C. Mock-ups shall display the full range of materials and workmanship required for completion of the project for approval by the Architect.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver all products to the site in original packaging, unopened, and undamaged, with manufacturer name and product identification visible thereon, manufacturer's instructions and Material Safety Data Sheets.
- B. Store products in a dry location and protected from dampness and freezing following manufacturer instructions.

#### 1.08 PROJECT/SITE CONDITIONS

- A. Normal conditions for the work of this Section shall be defined as when the air and surface temperatures are 50 degrees F and rising or less than 90 degrees F and falling. Refer to manufacturer application specifications for further guidance.
- B. Do not apply paint when the relative humidity exceeds 85 percent. Drying times are also affected by relative humidity. Those stated by manufactures are generally based on 50 percent RH and at approximately 77 degrees F. Refer to manufacturers application specifications for further guidance.
- C. Work shall not commence when rain, snow or below-freezing temperatures are expected within 24 hours. All surfaces shall be free of standing water, frost, and ice.
- D. Do not apply paint in the direct sun. Paint shall be applied only when the surface to be painted is in the shade and the sun is shining on the opposite elevation.

- E. The contractor is responsible for protecting existing adjacent materials and surfaces, and substrate during the execution of the work. Provide all necessary protection and work procedures to avoid damage to existing material assemblies not a part of the work in the Section.
- F. Provide visible barriers and / or warning tape around the perimeter of the work area for visitor protection. Protect nearby vehicles and adjacent structures from damage during the course of the work.
- G. Contractor shall coordinate paint work with the other trades involved in exterior and interior restoration work including, but not limited to, wood restoration and sealants. Complete repair or replacement of deteriorated wood prior to painting.
- H. Lead Based Paint:
  - 1. Many of the areas to be prepared for repainting retain coatings from the nineteenth and twentieth centuries.
  - 2. The Contractor should therefore assume that all existing painted surfaces contain lead unless tested to show otherwise, and shall take all necessary actions and precautions to assure safety of the public, property, the environment, and the workers in scraping, sanding, removing and disposing of any existing paint.
  - 3. This includes compliance with all applicable regulations including, but not limited to, the following:
    - a. OSHA 29 CFR 1926.62 (Lead in construction).
    - b. OSHA 29 CFR 1910.134 (Respiratory protection).
    - c. OSHA Hazard Communication Standard.
    - d. Compliance with all other applicable health, safety and environmental requirements of the government agencies having jurisdiction including, but not limited to the following:
      - i. State Department of Environmental Resources
      - ii. State Department of Labor
      - iii. State Department of Health
      - iv. Federal OSHA
      - v. Federal Environmental Protection Agency

- vi. Governmental agencies having jurisdiction over this work, including compliance with volatile organic compounds/volatile organic solvent regulations and abrasive surface preparation.

## **PART 2 – PRODUCTS**

### **2.01 PAINT MATERIALS**

- A. Acrylic Latex Paint: Provide best quality grade of various types of coatings as regularly manufactured by acceptable manufacturers.
- B. Oil/alkyd based paints: Provide best quality grade of various types of coatings as regularly manufactured by acceptable manufacturers.
- C. Casein Paint (milk-based paint): Factory-mixed with non-fading pigments. Provide best quality grade of various types of coatings as regularly manufactured by acceptable manufacturers.

### **2.02 ACCESSORY MATERIALS**

- A. Mineral Spirits, as recommended by paint manufacturer.
  - 1. A petroleum distillate that is used especially as a paint or varnish thinner.
  - 2. Other chemical or common names include: Benzine (not Benzene); Naphtha; Petroleum spirits, Solvent naphtha.
- B. Linseed Oil, raw or boiled, or other oils can be added to Casein paint.
- C. Joint Sealers: As specified in Section 07900.
- D. Fillers: Provide best quality filler material compatible with substrate being filled.
- E. Spackling compound shall be grit free when dry, non-shrinking and easily sanded to take any finish.
- F. Shellac for knot sealer shall be pure white cut with denatured alcohol.

### **2.03 EQUIPMENT**

Follow manufacturer's recommendation as to proper tools for use in the application of coatings. This includes the selection of various types of brushes, rollers and spray applicators.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. All wood repair and replacement work shall be completed prior to painting.

- B. Remove all hardware, hardware accessories, light fixtures and other appurtenances except where removal will cause harm to historic items. Document, catalog and store removed items so that they can be reinstalled in original position at the completion of work.
- C. The Contractor shall protect adjacent materials, and openings and assemblies from paint spatters and overspray.
- D. Do not paint over dirt, rust, scale, grease, moisture, or conditions otherwise detrimental to formation of a curable paint film.

### 3.02 PREPARATION

- A. Perform preparation and cleaning procedures in accordance with coating manufacturer's instructions and as herein specified, for each substrate condition and paint type. Prior to full scale cleaning, use test panels to determine the effectiveness of cleaning methods is recommended.
- B. Clean surfaces to be painted before applying paint or surface treatments. For guidance on cleaning exterior wood see 06300.01–Cleaning and Testing Atmospheric Soiling, Biogrowth, and Mold and 09910.04 – Cleaning and Testing Atmospheric Soiling on Painted Surfaces.
  - 1. Do not use bleach by large scale spray application since bleach can cause significant damage to historic materials and surrounding landscape plantings. Surfaces shall be free of loose or peeling paint, or other foreign substances. Proper methods should be applied to capture lead paint chips during removal. Wash surfaces to be painted with mild detergents. Remove all dirt and other foreign matter prior to paint application using the gentlest method possible to achieve positive results. Do not use metal bristled brushes or high pressure water.
  - 2. Remove Chalking Paint: Wash surfaces with solution of water and trisodium phosphate.
  - 3. Mold and mildew can be effectively removed by washing with a solution of water and trisodium phosphate
- C. Wood, General:
  - 1. Scrape and clean knots and apply a thin coat of white shellac before initial application of priming coat. Lightly sand surfaces and tack rag before finishing.
  - 2. For painted surfaces, fill holes and imperfections in finish surfaces with putty wood-filler after priming. Follow manufacturer specifications as to specific applications of filler. Sandpaper smooth and profile as required when dried.
  - 3. Each coat shall be checked and any imperfections, faulty material, poor workmanship, etc. shall be corrected before applying succeeding coat.

### 3.03 PREPARATION OF PAINT

Mix and prepare painting materials in accordance with manufacturer directions.

- A. Store materials not currently in use in tightly covered containers.
- B. Mixing of paint shall be in clean containers, free of foreign materials and residue.

#### 1.04 APPLICATION OF PAINT

##### A. General:

1. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness as recommended by coating manufacturer.
  2. Apply paint in accordance with manufacturer's directions and under adequate illumination. Use techniques best suited for each substrate condition and type of material being applied.
  3. For exterior surfaces, apply paint using brush, roller, or other method specified by the manufacturer and acceptable to the Architect. Use brushes best suited for the type of material being applied. Use rollers as recommended by paint manufacturer for material and texture required.
- B. Workmanship: Finished surface, regardless of method of paint application, shall show no evidence of improper application according to accepted trade practice.
- C. Scheduling Painting: Apply first coat as soon as practicable after preparation and before subsequent surface deterioration. Allow sufficient time between successive coatings to permit proper drying or curing as specified by the manufacturer.
- D. Prime Coats: Apply prime coat to all surfaces to be painted per manufacturer's specifications and acceptable to the Architect.
1. The use of various types of primers is specific to the needs of the particular coating application being used. Follow manufacturer's guidelines for application that are acceptable to the Architect.
  2. Primer, primer-sealer, and knot sealer must be thoroughly dried before application of the next coat.
- E. Finish coats:
1. Apply at least two coats of paint or as indicated in the finish schedule to insure complete coverage.
  2. Do not apply additional coats of paint until the film to be re-coated is sufficiently cured to receive the next coat.
  3. Completely cover to provide an opaque, smooth surface of uniform finish, color,



appearance, and coverage.

F. Clean-Up:

1. Upon completion of paint work, clean window glass and other paint-splattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or to otherwise damage finished surfaces.
  2. At completion of work, including work of other trades, touch-up and restore all damaged or defaced painted surfaces.
- 3.05 FINAL REPORT: Provide a final report of complete work including all approved submittals and photographs of the repaired areas taken before, during and after the work.

END OF SECTION

## **Appendix D**

### Technical Resources

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# 47 PRESERVATION BRIEFS

## Maintaining the Exteriors of Small and Medium Size Historic Buildings

Sharon C. Park, FAIA



National Park Service  
U.S. Department of the Interior  
Heritage Preservation Services



Preservation is defined as “the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the *ongoing maintenance and repair* of historic materials and features rather than extensive replacement and new construction.”<sup>1</sup>

Maintenance helps preserve the integrity of historic structures. If existing materials are regularly maintained and deterioration is significantly reduced or prevented, the integrity of materials and workmanship of the building is protected. Proper maintenance is the most cost effective method of extending the life of a building. As soon as a building is constructed, restored, or rehabilitated, physical care is needed to slow the natural process of deterioration. An older building has already experienced years of normal weathering and may have suffered from neglect or inappropriate work as well.

Decay is inevitable but deterioration can accelerate when the building envelope is not maintained on a regular basis. Surfaces and parts that were seamlessly joined when the building was constructed may gradually become loose or disconnected; materials that were once sound begin to show signs of weathering. If maintenance is deferred, a typical response is to rush in to fix what has been ignored, creating additional problems. Work done on a crisis level can favor inappropriate treatments that alter or damage historic material.

There are rewards for undertaking certain repetitive tasks consistently according to a set schedule. Routine and preventive care of building materials is the most effective way of slowing the natural process of deterioration. The survival of historic buildings in good condition is primarily due to regular upkeep and the preservation of historic materials.

Well-maintained properties tend to suffer less damage from storms, high winds, and even small earthquakes. Keeping the roof sound, armatures and attachments such

as shutters tightened and secured, and having joints and connections functioning well, strengthens the ability of older buildings to withstand natural occurrences.

Over time, the cost of maintenance is substantially less than the replacement of deteriorated historic features and involves considerably less disruption. Stopping decay before it is widespread helps keep the scale and complexity of work manageable for the owner.

This *Preservation Brief* is designed for those responsible for the care of small and medium size historic buildings, including owners, property administrators, in-house maintenance staff, volunteers, architects, and maintenance contractors. The Brief discusses the benefits of regular inspections, monitoring, and seasonal maintenance work; provides general guidance on maintenance treatments for historic building exteriors; and emphasizes the importance of keeping a written record of completed work.

### Getting Started

Understanding how building materials and construction details function will help avoid treatments that are made in an attempt to simplify maintenance but which may also result in long-term damage. It is enticing to read about “maintenance free” products and systems, particularly waterproof sealers, rubberized paints, and synthetic siding, but there is no such thing as maintenance free when it comes to caring for historic buildings. Some approaches that initially seem to reduce maintenance requirements may over time actually accelerate deterioration.

Exterior building components, such as roofs, walls, openings, projections, and foundations, were often constructed with a variety of functional features, such as overhangs, trim pieces, drip edges, ventilated cavities, and painted surfaces, to protect against water infiltration, ultraviolet deterioration, air infiltration, and



*Figure 1. Maintenance involves selecting the proper treatment and protecting adjacent surfaces. Using painter's tape to mask around a brass doorknocker protects the painted door surface from damage when polishing with chemical compounds. On the other hand, hardware with a patinated finish was not intended to be polished and should simply be cleaned with a damp cloth.*



## Cautions During Maintenance Work

All maintenance work requires attention to safety of the workers and protection of the historic structure. Examples include the following:

- Care should be taken when working with historic materials containing lead-based paint. For example, damp methods may be used for sanding and removal to minimize air-borne particles. Special protection is required for workers and appropriate safety measures should be followed.
- Materials encountered during maintenance work, such as droppings from pigeons and mice, can cause serious illnesses. Appropriate safety precautions need to be followed. Services of a licensed contractor should be obtained to remove large deposits from attics and crawlspaces.
- Heat removal of paint involves several potential safety concerns. First, heating of lead-containing paint requires special safety precautions for workers. Second, even at low temperature levels, heat removal of paint runs the risk of igniting debris in walls. Heat should be used only with great caution with sufficient coverage by smoke detectors in work areas. Work periods need to be timed to allow monitoring after completion of paint removal each day, since debris will most often smolder for a length of time before breaking out into open flame. The use of torches, open flames, or high heat should be avoided.
- Many chemical products are hazardous and volatile organic compounds (VOC) are banned in many areas. If allowed, appropriate respirators and other safety precautions are essential for use.
- Personal protection is important and may require the use of goggles, gloves, mask, closed-toed shoes, and a hard hat.
- Electrical service should be turned off before inspecting a basement after a flood or heavy rain, where there is high standing water.

pest infestation. Construction assemblies and joints between materials allow for expansion and contraction and the diffusion of moisture vapor, while keeping water from penetrating the building envelope. Older buildings use such features effectively and care must be taken to retain them, avoiding the temptation to reduce air infiltration or otherwise alter them.

Monitoring, inspections, and maintenance should all be undertaken with safety in mind. Besides normal safety procedures, it is important to be cognizant of health issues more commonly encountered with older buildings, such as lead-based paint, asbestos, and bird droppings, and to know when it is necessary to seek professional services (see sidebar).

Original building features and examples of special craftsmanship should be afforded extra care. The patina or aging of historic materials is often part of the charm and character of historic buildings. In such cases, maintenance should avoid attempts to make finishes look new by over-cleaning or cladding existing materials. As with any product that has the potential to harm historic materials, the selection of a cleaning procedure should always involve testing in a discreet location on the building to ensure that it will not abrade, fade, streak, or otherwise damage the substrate (Fig 1).



Maintenance Plan, Schedules and Inspection

Organizing related work into a written set of procedures, or a Maintenance Plan, helps eliminate duplication, makes it easier to coordinate work effort, and creates a system for prioritizing maintenance tasks that takes into account the most vulnerable and character-defining elements.

The first time a property owner or manager establishes a maintenance plan or program, it is advisable to have help from a preservation architect, preservation consultant, and/or experienced contractor. Written procedures should outline step-by-step approaches that are custom- tailored to a building. No matter how small the property, every historic site should have a written guide for maintenance that can be as simple as:

- 1) Schedules and checklists for inspections;
- 2) Forms for recording work, blank base plans and elevations to be filled in during inspections and upon completion of work;
- 3) A set of base-line photographs to be augmented over time;
- 4) Current lists of contractors for help with complex issues or in case of emergencies;
- 5) Written procedures for the appropriate care of specific materials, including housekeeping, routine care, and preventive measures;
- 6) Record-keeping sections for work completed, costs, warranty cards, sample paint colors, and other pertinent material.

This information can be kept in one or more formats, such as a three-ring binder, file folders, or a computer

database. It is important to keep the files current with completed work forms to facilitate long-term evaluations and planning for future work (Fig 2).

Proper maintenance depends on an organized plan with work prescribed in manageable components. Regular maintenance needs to be considered a priority both in terms of time allotted for inspections and for allocation of funding.

Maintenance work scheduling is generally based on a variety of factors, including the seriousness of the problem, type of work involved, seasonal appropriateness, product manufacturer's recommendations, and staff availability. There are other variables as well. For example, building materials and finishes on southern and western exposures will often weather faster than those on northern or eastern exposures. Horizontal surfaces facing skyward usually require greater maintenance than vertical ones; in regions with moderate or heavy rainfall, wood and other materials in prolonged shadow are subject to more rapid decay.

Maintenance costs can be controlled, in part, through careful planning, identification of the amount of labor required, and thoughtful scheduling of work. Maintenance schedules should take into account daily and seasonal activities of the property in order to maximize the uninterrupted time necessary to complete the work. Institutions generally need to budget annually between 2 and 4 percent of the replacement value of the building to underwrite the expense of full building maintenance.<sup>2</sup> Use of trained volunteers to undertake maintenance can help reduce costs.

Exterior inspections usually proceed from the roof down to the foundation, working on one elevation at

Cyclic Building Inspection Checklist: Horse Stable			Inspection date: 04/24/05	
Building Feature	Material(s)	Condition Description	Maintenance Action Required	Work Done
ROOF:				
Covering	Clay tile	Two slipped tiles	Reattach tiles	5/4/05
	Painted metal standing seam	Slight corrosion; blistering paint on metal roof section	Sand and repaint area that is peeling	6/8/05
Flashing	Painted metal	Flashing in good condition	N/A	N/A
Gutters/ Downspouts	6" half round galvanized metal	Gutter sagging; downspouts OK	Realign gutter and put on new hanger strap	5/4/05
			Flush out downspouts	5/5/05
Chimneys	No masonry chimney	N/A	N/A	N/A
Attachments/ Penetrations	Metal vent stack and weathervane	Vent stack hood has some peeling paint; vane OK	Sand and repaint vent stack	6/8/05

Figure 2. All personnel associated with a historic structure need to become acquainted with how existing building features should appear and during their daily or weekly routines look for changes that may occur. This will help augment the regular maintenance inspection that will occur at specified intervals based on seasonal changes, use, and other factors. A segment of an inspection form showing the roof elements of a horse stable is shown. The inspection report should be kept along with the maintenance plan and other material in notebook, file or electronic form.



a time, moving around the building in a consistent direction. On the interior, the attic, inside surfaces of exterior walls, and crawlspaces or basements should be examined for signs of potential or existing problems with the building envelope.

The following chart lists suggested inspection frequencies for major features associated with the building's exterior, based on a temperate four-season climate and moderate levels of annual rainfall. For areas of different climate conditions and rainfall, such as in the more arid southwest, the nature of building decay and frequency of inspections will vary. For buildings with certain inherent conditions, heavy use patterns, or locations with more extreme weather conditions, the frequency of inspections should be altered accordingly.

*Note: All building features should be inspected after any significant weather event such as a severe rainstorm or unusually high winds.*

INSPECTION FREQUENCY CHART		
Feature	Minimum Inspection Frequency	Season
Roof	Annually	Spring or fall; every 5 years by roofer
Chimneys	Annually	Fall, prior to heating season; every 5 years by mason
Roof Drainage	6 months; more frequently as needed	Before and after wet season, during heavy rain
Exterior Walls and Porches	Annually	Spring, prior to summer/fall painting season
Windows	Annually	Spring, prior to summer/fall painting season
Foundation and Grade	Annually	Spring or during wet season
Building Perimeter	Annually	Winter, after leaves have dropped off trees
Entryways	Annually; heavily used entries may merit greater frequency	Spring, prior to summer/fall painting season
Doors	6 months; heavily used entry doors may merit greater frequency	Spring and fall; prior to heating/cooling seasons
Attic	4 months, or after a major storm	Before, during and after wet season
Basement/Crawlspace	4 months, or after a major storm	Before, during and after rain season

Survey observations can be recorded on a standardized report form and photographs taken as a visual record. All deficient conditions should be recorded and placed on a written schedule to be corrected or monitored.

## BUILDING COMPONENTS

For purposes of this discussion, the principal exterior surface areas have been divided into five components and are presented in order from the roof down to grade. While guidance for inspection and maintenance is provided for each component, this information is very general in nature and is not indeed to be comprehensive in scope. Examples have been selected to address some typical maintenance needs and to help the reader avoid common mistakes.

### Roofs/chimneys

The roof is designed to keep water out of a building. Thus one of the principal maintenance objectives is to ensure water flows off the roof and into functional gutters and downspouts directly to grade and away from the building—and to prevent water from penetrating the attic, exterior walls, and basement of a building. (Note: Some buildings were designed without gutters and thus assessments must be made as to whether rain water is being properly addressed at the foundation and perimeter grade.) Keeping gutters and downspouts cleared of debris is usually high on the list of regular maintenance activities (Fig 3). Flashing around chimneys, parapets, dormers, and other appendages to the roof also merit regular inspection and appropriate maintenance when needed. The material covering the roof—wood shingles, slate, tile, asphalt, sheet metal, rolled roofing—requires maintenance both to ensure a watertight seal and to lengthen its service life; the type and frequency of maintenance varies with the roofing material. Older chimneys and parapets also require inspection and maintenance. With the exception of cleaning and minor repairs to gutters and downspouts, most roof maintenance work will necessitate use of an outside contractor.

#### Inspection:

The functioning of gutters and downspouts can be safely observed from the ground during rainy weather and when winter ice has collected. Binoculars are a useful tool in helping to identify potential roofing problems from the same safe vantage point. Careful observation from grade helps to identify maintenance needs between close-up inspections by an experienced roofer. Observation from the building interior is also important to identify possible leak locations. When access can be safely gained to the roof, it is important to wear shoes with slip-resistant soles and to use safety ropes.





Figure 3. Keeping gutters clean of debris can be one of the most important cyclical maintenance activities. On this small one-story addition, a garden hose is being used to flush out the trough to ensure that the gutter and downspouts are unobstructed. Gutters on most small and medium size buildings can be reached with an extension ladder and a garden hose. Photo: Bryan Blundell.

Depending on the nature of the roof, some common conditions of concern to look for are:

- sagging gutters and split downspouts;
- debris accumulating in gutters and valleys;
- overhanging branches rubbing against the roof or gutters
- plant shoots growing out of chimneys;
- slipped, missing, cracked, bucking, delaminating, peeling, or broken roof coverings;
- deteriorated flashing and failing connections at any intersection of roof areas or of roof and adjacent wall;
- bubbled surfaces and moisture ponding on flat or low sloped roofs;
- evidence of water leaks in the attic;
- misaligned or damaged elements, such as decorative cresting, lightning rods, or antennas; and
- cracked masonry or dislodged chimney caps.

### Maintenance:

- Remove leaves and other debris from gutters and downspouts. Utilize a ladder with a brace device, if

necessary, to keep the ladder from crushing the gutter. Use a garden hose to flush out troughs and downspouts. Patch or repair holes in gutters using products such as fiberglass tape and epoxy adhesive in metal gutters. Avoid asphalt compounds since acidic material can cause further deterioration of metal gutters.

- Correct misaligned gutters and adjust, if necessary, so that water flows to drains and does not pond. If gutter edges sag, consider inserting wooden wedges between the fascia board and the back of the gutter to add support. Seal leaking seams or pinholes in gutters and elbows.

- Broom sweep branch or leaf debris away from shingles, valleys, and crickets, particularly around chimneys and dormers.

- Where mechanical equipment is mounted on flat or low-sloped roofs, ensure that access for maintenance

can be provided without damaging the roof. Clean out trapped leaves and debris from around equipment base and consider adding a protective walkway for access.

- Remove biological growth where it is causing erosion or exfoliation of roofing. Use low-pressure garden hose water and a natural or nylon scrubbing brush to remove such growth, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Most growth is acidic and while there are products designed to kill spores, such as diluted chlorine bleach, they should be avoided. Even fairly weak formulas can still cause unexpected color changes, efflorescence, or over-splash damage to plantings or surfaces below the roof. Where appropriate, trim adjacent tree branches to increase sunlight on the roof since sunlight will deter further biological growth.

- Re-secure loose flashing at the dormers, chimneys or parapets. Clean out old mortar, lead, lead wool, or fastening material and make sure that flashing is properly inserted into reglet (slot) joints, taking care not to damage the substrate. Avoid installing new step flashing as a single metal component where multiple pieces are required to provide proper waterproofing. Also avoid attaching step flashing with mastic or sealant. Properly re-bed all step flashing. Use appropriate non-ferrous flashing metal or painted metal if needed. Since cap, step, valley, cricket, and apron flashings each have specific overlap and extension requirements, replacement flashing should match the existing material unless there has been a proven deficiency.





Figure 4. Damage to roofs often requires immediate attention. As a temporary measure, this damaged roof tile could be replaced with a brown aluminum sheet wedged between the existing tiles. Photo: Chad Randl.



Figure 5. The use of a sealant to close an exposed joint is not always an effective long-term solution. Where this decorative wood element connects to the slate roof, the sealant has failed within a short time and a proper metal flashing collar is being fitted instead. Photo: Bryan Blundell.

- Repoint joints in chimneys, parapet, or balustrade capping stones using a hydraulic lime mortar or other suitable mortar where the existing mortar has eroded or cracked, allowing moisture penetration. In general, a mortar that is slightly weaker than the adjacent masonry should be used. This allows trapped moisture in the masonry to migrate out through the mortar and not the masonry. Spalled masonry is often evidence of the previous use of a mortar mix that was too hard.
- Use professional services to repair chimneys and caps. Avoid the use of mortar washes on masonry since they tend to crack, allowing moisture to penetrate and promoting masonry spalling. Repoint masonry with a durable mortar that is slightly weaker than the adjacent masonry. Slope the masonry mortar cap to insure drainage away from the flue. If a chimney rain cap is installed, ensure adequate venting and exhaust.
- As a temporary measure, slip pieces of non-corrosive metal flashing under or between damaged and missing roofing units until new slate, shingles, or tile can be attached. Repair broken, missing or damaged roofing units with ones that match. Follow roofing supplier and industry guidance on inserting and attaching replacement units (Fig 4). Avoid using temporary asphalt patches as it makes a proper repair difficult later on.
- For long-term preservation of wooden shingle roofs coated with a preservative, recoat every few years following the manufacturer's recommendations. Be aware of environmental considerations.
- Scrape and repaint selected areas of coated ferrous metal roofing as needed; repaint on a regularly

scheduled basis. Ferrous metal roofs can last a long time if painted regularly. Alkyd coatings are generally used on metal roofs; be sure to wash and properly prepare the area beforehand. Environmental regulations may restrict the use of certain types of paints. Apply the coating system in accordance with manufacturer's recommendations. Prepare the surface prior to application to obtain good adhesion with the prime coat. Apply both a prime coat and a topcoat for good bonding and coverage; select primer and topcoat products from the same manufacturer.

- Re-secure loose decorative elements, such as finials and weathervanes. Seek professional advice if decorative elements exhibit considerable corrosion, wood rot, or structural instability. Small surface cracks may benefit from a flexible sealant to keep moisture out; sealants have a limited life and require careful inspection and periodic replacement (Fig 5).

## Exterior Walls

Exterior walls are designed to help prevent water infiltration, control air infiltration, and serve as a barrier for unwanted animals, birds and insects. The primary maintenance objective is to keep walls in sound condition and to prevent water penetration, insect infestation, and needless decay (Fig 6). Depending on the materials and construction methods, walls should have an even appearance, free from unwanted cracks, and should be able to shed excess moisture. Where surfaces are significantly misaligned or where there are bulging wall sections



or cracks indicative of potential structural problems, seek professional guidance as to the cause of distress and appropriate corrective measures. Wood-frame construction generally will require more frequent maintenance than buildings constructed of brick, stone, or terra cotta (Fig 7).

### *Inspections:*

It is best to inspect walls during dry as well as wet weather. Look for moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any patterns on elevation drawings or standard recording forms. Monitoring the interior wall for moisture or other potential problems is important as well. Look for movement in cracks, joints, and around windows and doors and try to establish whether movement is seasonal in nature (such as related to shrinkage of wood during dry weather) or signs of an ongoing problem. For moderate size buildings, a ladder or mechanical lift may be necessary, though in some cases the use of binoculars and observations made from windows and other openings will be sufficient. When examining the walls, some common conditions of concern to look for are:

- Misaligned surfaces, bulging wall sections, cracks in masonry units, diagonal cracks in masonry joints, spalling masonry, open joints, and nail popping;
- Evidence of wood rot, insect infestation, and potentially damaging vegetative growth;
- Deficiencies in the attachment of wall mounted lamps, flag pole brackets, signs, and similar items;
- Potential problems with penetrating features such as water spigots, electrical outlets, and vents;
- Excessive damp spots, often accompanied by staining, peeling paint, moss, or mold; and
- General paint problems (Fig 8).

### *Maintenance:*

- Trim tree branches away from walls. Remove ivy and tendrils of climbing plants by first cutting at the base of the vine to allow tendrils to die back, and later using a plastic scraper to dislodge debris and an appropriate digging tool to dislodge and remove root systems. Be cautious if using a commercial chemical to accelerate root decay; follow safety directions and avoid contact of chemicals with workers and wall materials.

- Wash exterior wall surfaces if dirt or other deposits are causing damage or hiding deterioration; extend



Figure 6. Stucco applied to an exterior wall or foundation was intended to function as a watertight surface. Unless maintained, rainwater will penetrate open joints and cracks that may occur over time. A spalled section of stucco indicates some damage has occurred and a wooden mallet is being used to tap the surface to determine whether the immediate stucco has lost adhesion. Photo: Bryan Blundell.



Figure 7. One of the advantages of wood shingles as a wall covering is that individual shingles that are damaged can easily be replaced. On this highly exposed corner, worn shingles have been selectively replaced to help safeguard against water damage. The new shingles will be stained to match the existing shingles.



Figure 8. The paint on the siding of this south-facing wall needs to be scraped, sanded, primed and repainted. Postponing such work will lead to further paint failure, require greater preparatory costs, and could even result in the need to replace some siding. Photo: Charles Fisher.





*Figure 9. To help extend a repainting cycle, dirt and spider webs should be removed before permanent staining occurs. In this case, a natural bristle brush and a soft damp cloth are being used to remove insect debris and refresh the surface appearance.*

scheduled times for cleaning for cosmetic purposes to reduce frequency (Fig 9). When cleaning, use the gentlest means possible; start with natural bristle brushes and water and only add a mild phosphate-free detergent if necessary. Use non-abrasive cleaning methods and low-pressure water from a garden hose. For most building materials, such as wood and brick, avoid abrasive methods such as mechanical scrapers and high-pressure water or air and such additives as sand, natural soda, ice crystals, or rubber products. All abrasives remove some portion of the surface and power-washing drives excessive moisture into wall materials and even into wall cavities and interior walls. If using a mild detergent, two people are recommended, one to brush and one to prewet and rinse. When graffiti or stains are present, consult a preservation specialist who may use poultices or mild chemicals to remove the stain. If the entire building needs cleaning other than described above, consult a specialist.

- Repoint masonry in areas where mortar is loose or where masonry units have settled. Resolve cause of cracks or failure before resetting units and repointing. Rake out joints by hand, generally avoiding rotary saws or drills, to a depth of 2 ½ times the width of the joint (or until sound mortar is encountered), to make sure that fresh mortar will not pop out. Repointing mortar should be lime-rich and formulated to be slightly weaker than the masonry units and to match the historic mortar in color, width, appearance, and tooling. Off-the-shelf pre-mixed cement mortars are not appropriate for most historic buildings. Avoid use of joint sealants in place of

mortar on vertical masonry wall surfaces, as they are not breathable and can lead to moisture-related damage of the adjacent masonry (Fig 10).

- Correct areas that trap unwanted moisture. Damaged bricks or stone units can sometimes be removed, turned around, and reset, or replaced with salvaged units. When using traditional or contemporary materials for patching wood, masonry, metal, or other materials, ensure that the materials are compatible with the substrate; evaluate strength, vapor permeability, and thermal expansion, as well as appearance.
- When patching is required, select a compatible patch material. Prepare substrate and install patch material according to manufacturer's recommendations; respect existing joints. Small or shallow surface defects may not require patching; large or deep surface defects may be better addressed by installation of a dutchman unit than by patching.
- Where a damaged area is too large to patch, consider replacing the section with in-kind material. For stucco and adobe materials, traditional patching formulas are recommended.
- When temporarily removing wood siding to repair framing or to tighten corner boards and loose trim, reuse the existing siding where possible. Consider using stainless steel or high strength aluminum nails as appropriate. Putty or fill nail holes flush with siding prior to repainting. Back-prime any installed wood with





Figure 10. Repointing of masonry should usually be approached as repair rather than maintenance work in part because of the need for a skilled mason familiar with historic mortar. In this case, a moisture condition was not corrected and the use of a waterproof coating and off-the-shelf Portland cement mortar trapped water and resulted in further damage to these 19th century bricks. Photo: NPS files.

one coat of primer and coat end grain that might be exposed with two coats of primer.

- Prepare, prime, and spot paint areas needing repainting. Remember that preparation is the key to a successful long lasting paint job. Ensure beforehand the compatibility of new and existing paints to avoid premature paint failure. Remove loose paint to a sound substrate; sand or gently rough surface if needed for a good paint bond; wipe clean; and repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use top quality coating materials. Generally paint when sun is not shining directly onto surfaces to be painted.

- Remove deteriorated caulks and sealants, clean, and reapply appropriate caulks and sealants using backer rods as necessary. Follow manufacturer's instructions regarding preparation and installation.

- Correct deficiencies in any wall attachments such as awning and flag pole anchors, improperly installed electrical outlets, or loose water spigots.

## Openings

Exterior wall openings primarily consist of doors, windows, storefronts, and passageways. The major maintenance objectives are to retain the functioning nature of the opening and to keep in sound condition the connection between the opening and the wall in order to reduce air and water infiltration.

## Inspection:

Wall openings are typically inspected from inside as well as out. Examinations should include the overall material condition; a check for unwanted water penetration, insect infiltration, or animal entry; and identification of where openings may not be properly functioning. Frames should be checked to make sure they are not loose and to ascertain whether the intersection between the wall and the frame is properly sealed. Secure connections of glazing to sash and between sash and frames are also important. Particular attention should be placed on exposed horizontal surfaces of storefronts and window frames as they tend to deteriorate much faster than vertical surfaces. Inspections should identify:

- loose frames, doors, sash, shutters, screens; storefront components, and signs that present safety hazards;
- slipped sills and tipped or cupped thresholds;
- poorly fitting units and storm assemblies, misaligned frames, drag marks on thresholds from sagging doors and storm doors;
- loose, open, or decayed joints in door and window frames, doors and sash, shutters, and storefronts;
- loose hardware, broken sash cords/chains, worn sash pulleys, cracked awning, shutter and window hardware, locking difficulties, and deteriorated weatherstripping and flashing;
- broken/cracked glass, loose or missing glazing and putty;
- peeling paint, corrosion or rust stains; and
- window well debris accumulation, heavy bird droppings, and termite and carpenter ant damage.

## Maintenance:

- Replace broken or missing glass as soon as possible; in some cases cracked glass may be repaired using specialty glues. For historic crown glass and early cylinder glass, a conservation approach should be considered to repair limited cracks. Where panes with a distinct appearance are missing, specialty glass should be obtained to match, with sufficient inventory kept for future needs. Avoid using mechanical devices to remove old putty and match historic putty bevels or details when undertaking work.

- Reputty window glazing where putty is deteriorated or missing. Take care in removing putty so as not to crack or break old glass or damage muntins and sash frames. Re-glaze with either traditionally formulated



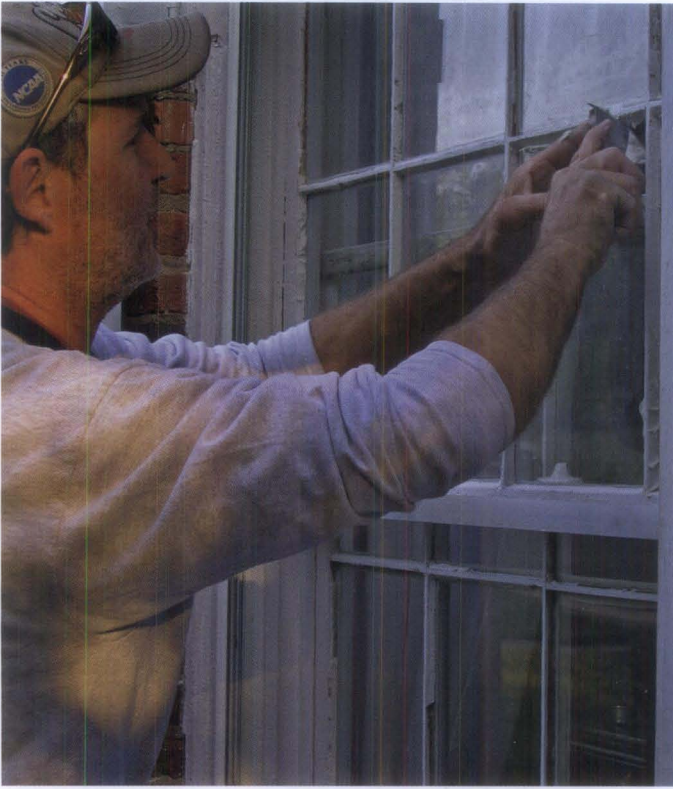


Figure 11. Glazing putty should be maintained in sound condition to prevent unwanted air infiltration and water damage. New glazing putty should be pulled tight to the glass and edge of the wood, creating a clean bevel that matches the historic glazing.

oil putties or modern synthetic ones, making sure to properly bed the glass and secure with glazing points (Fig 11).

- Clean window glass, door glazing, storefronts, transom prism lights, garage doors, and storm panels using a mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements if not totally removed. When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth. Avoid high-pressure washes.

- Clean handles, locks and similar hardware with a soft, damp cloth. Use mineral spirits or commercial cleaners very sparingly, as repeated use may remove original finishes. Most metal cleaners include ammonia that can streak and stain metal, so it is important to remove all cleaning residue. Polished hardware subject to tarnishing or oxidation, particularly doorknobs, often benefits from a thin coat of paste wax (carnauba), hand buffed to remove extra residue. Avoid lacquer finishes for high use areas, as they require more extensive maintenance. Patinated finishes should not be cleaned with any chemicals, since the subtle aged appearance contributes to the building's character.

- Remove and clean hardware before painting doors and windows; reinstall after the paint has dried.
- Tighten screws in doorframes and lubricate door hinges, awning hardware, garage door mechanisms, window sash chains, and pulleys using a graphite or silicone type lubricant.

## Contracting Maintenance and Repair Work

Many contractors are very proficient in using modern construction methods and materials; however, they may not have the experience or skill required to carry out maintenance on historic buildings. The following are tips to use when selecting a contractor to work on your historic building:

1. Become familiar with work done on similar historic properties in your area so that you can obtain names of possible preservation contractors.
2. Be as specific as possible in defining the scope of work you expect to undertake.
3. Ask potential contractors for multiple references (three to five) and visit previous work sites. Contact the building owner or manager and ask how the job proceeded; if the same work crew was retained from start to finish; if the workers were of a consistent skill level; whether the project was completed in a reasonable time; and whether the person would use the contractor again.
4. Be familiar with the preservation context of the work to be undertaken. Use the written procedures in your maintenance plan to help define the scope of work in accordance with preservation standards and guidelines. Always request that the gentlest method possible be used. Use a preservation consultant if necessary to ensure that the work is performed in an appropriate manner.
5. Request in the contract proposal a detailed cost estimate that clearly defines the work to be executed, establishes the precautions that will be used to protect adjoining materials, and lists specific qualified subcontractors, if any, to be used.
6. Insure that the contractor has all necessary business licenses and carries worker compensation.



- Check weather stripping on doors and windows and adjust or replace as necessary. Use a durable type of weather stripping, such as spring metal or high quality synthetic material, avoiding common brush and bulb or pile weather stripping that require more frequent replacement.

- Adjust steel casement windows as needed for proper alignment and tight fit. Avoid additional weather stripping as this may lead to further misalignment, creating pathways for air and water infiltration.

- Check window sills for proper drainage. Fill cracks in wood sills with a wood filler or epoxy. Follow manufacturer's instructions for preparation and installation. Do not cover over a wood sill with metal panning, as it may trap moisture and promote decay.

- Repair, prime, and repaint windows, doors, frames, and sills when needed. Clean out putty debris and paint chips from windows using a wet paper towel and dispose of debris prior to repair or repainting. Take appropriate additional precautions when removing lead-based paint. Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture (Fig 12). Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. Immediately prime steel sash after paint is removed and the substrate prepared for repainting.

- Adjust wood sash that bind when operated. Apply beeswax, paraffin, or similar material to tracks or sash runs for ease of movement. If sash are loose, replace worn parting beads. Sash runs traditionally were unpainted between the stop and parting bead; removing subsequent paint applications will often help improve sash operation.

- Correct perimeter cracks around windows and doors to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. Reduce excess air infiltration around windows by repairing and lubricating sash locks so that windows close tightly.



*Figure 12. Good surface preparation is essential for long lasting paint. Scraping loose paint, filling nail holes and cracks, sanding, and wiping with a damp cloth prior to repainting are all important steps whether touching up small areas or repainting an entire feature. Always use a manufacturer's best quality paint. Windows and shutters may need repainting every five to seven years, depending on exposure and climate.*



*Figure 13. Window air conditioning units can cause damage to surfaces below when condensation drips in an uncontrolled manner. Drip extension tubes can sometimes be added to direct the discharge.*



- Remove debris beneath window air conditioning units and ensure that water from units does not drain onto sills or wall surfaces below (Fig 13). Removal of air conditioning units when not in season is recommended.

- Adjust storm panels and clean weep holes; check that weep holes at the bottom of the panels are open so water will not be trapped on the sill. Exterior applied storm windows are best attached using screws and not tightly adhered with sealant. Use of sealant makes storm units difficult to remove for maintenance and can contribute to moisture entrapment if weep holes become clogged.

- Remove weakened or loose shutters and store for later repair. Consider adding a zinc or painted metal top to shutters as a protective cap to cover the wood's exposed end grain. This will extend the life of the shutters.

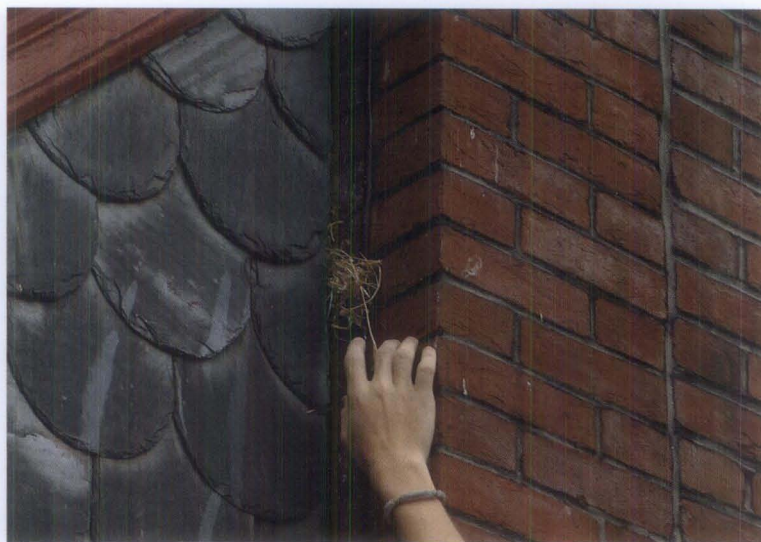
## Projections

Numerous projections may exist on a historic building, such as porches, dormers, skylights, balconies, fire escapes, and breezeways. They are often composed of several different materials and may include an independent roof. Principal maintenance objectives include directing moisture off these features and keeping weathered surfaces in good condition. Secondary projections may include brackets, lamps, hanging signs, and similar items that tend to be exposed to the elements.

### Inspection:

In some cases, projections are essentially independent units of a building and so must be evaluated carefully for possible settlement, separation from the main body of the building, and materials deterioration. Some electrical features may require inspection by a electrician or service technician. Common conditions of concern to look for are:

- damaged flashing or tie-in connections of projecting elements;
- misaligned posts and railings;
- deteriorated finishes and materials, including peeling paint, cupped and warped decking, wood deterioration, and hazardous steps;
- evidence of termites, carpenter ants, bees, or animal pests (Fig 14);
- damaged lamps, unsafe electrical outlets or deteriorated seals around connections;
- loose marker plaques, sign, or mail boxes; and



*Figure 14. When inspecting connections between projections and the main building, look for areas where birds, bees and pests may enter or nest. Birds have been nesting in this porch roof and the area is being cleaned of their debris. Where an opening exists, it may be necessary to cover it with a trim piece, screening, or sealant. Photo: Bryan Blundell.*

- rust and excessive wear of structural, anchorage, and safety features of balconies and fire escapes.

### Maintenance:

- Selectively repair or replace damaged roofing units on porches and other projections. Ensure adequate drainage away from the building. Repair flashing connections as needed; clean and seal open joints as appropriate.
- Secure any loose connections, such as on porch rails or fire escapes.
- Maintain ferrous metal components by following manufacturer's recommendation for cleaning and repainting. Remove rust and corrosion from porch handrails, balconies, fire escapes, and other metal features; prepare, prime, and repaint using a corrosion-inhibitive coating system. Apply new primer before new corrosion sets in, followed by new topcoat. Take appropriate safety measures when dealing with existing lead-based paint and in using corrosion-removal products (Fig 15).
- Reattach loose brackets, lamps, or signs. With electrical boxes for outlets or lighting devices, ensure that cover plates are properly sealed. Prime and paint metal elements as needed.
- Keep porch decks and steps free from dust, dirt, leaf debris, and snow as soon as it accumulates using a broom or plastic blade shovel.
- Repair areas of wood decay or other damage to railings, posts, and decorative elements. Repair with wood dutchman, wood putty, or epoxy filler, as appropriate; replace individual elements as needed.





Figure 15. Metal projecting elements on a building, such as sign armatures and railings, are easily subject to rust and decay. Proper surface preparation to remove rust is essential. Special metal primers and topcoats should be used.

Prime and repaint features when necessary and repaint horizontal surfaces on a more frequent basis.

- Sand and repaint porch floorboards to keep weather surfaces protected. The exposed ends of porch floorboards are especially susceptible to decay and may need to be treated every year or two.
- Carefully cut out damaged or buckled porch flooring and replace with wood to match. Back-prime new wood that is being installed; treat end grain with wood preservative and paint primer. Ensure that new wood is adequately kiln or air-dried to avoid shrinkage and problems with paint adherence.
- Repair rotted stair stringers; adjust grade or add stone pavers at stair base to keep wooden elements from coming into direct contact with soil.
- Consider durable hardwoods for replacement material where beading, chamfering, or other decorative work is required in order to match existing features being replaced. Although appropriate for certain applications, pressure treated lumber is hard to tool and may inhibit paint adherence if not allowed to weather prior to coating application.
- Clean out any debris from carpenter bees, ants, termites, and rodents, particularly from under porches. Replace damaged wood and add screening or lattice to discourage rodents. Consider treating above ground features with a borate solution to deter termites and wood rot and repaint exposed surfaces.

## Foundations and Perimeter Grades

The foundation walls that penetrate into the ground, the piers that support raised structures, and the ground immediately around a foundation (known as grade) serve important structural functions. To help sustain these functions, it is important that there is

good drainage around and away from the building. The maintenance goal is to prevent moisture from entering foundations and crawl spaces and damaging materials close to the grade, and to provide ventilation in damp areas.

### Inspection:

Inspections at the foundation should be done in conjunction with the inspection of the downspouts to ensure that water is being discharged a sufficient distance from the building perimeter to avoid excessive dampness in basements or crawl spaces. In addition, crawl spaces should be adequately vented to deter mold and decay and should be screened or otherwise secured against animals. Look for:

- depressions or grade sloping toward the foundation; standing water after a storm;



Figure 16. This chronically wet area has a mildew bloom brought on by heat generated from the air-conditioning condenser unit. The dampness could be caused by a clogged roof gutter, improper grading, or a leaking hose bibb.



## Sealants and Caulks

Using sealants and caulks has become a familiar part of exterior maintenance today. As the use of precision joinery and certain traditional materials to render joints more weathertight has waned in recent years, caulks and more often elastomeric sealants are used to seal cracks and joints to keep out moisture and reduce air infiltration. Where cracks and failing joints are indicators of a serious problem, sealants and caulks may be used as a temporary measure. In some cases they may actually exacerbate the existing problem, such as by trapping moisture in adjacent masonry, and lead to more costly repairs.

Manufacturer's recommendations provide instructions on the proper application of caulks and sealants. Special attention should be placed on ensuring that the subsurface or joint is properly prepared and cleaned. Backer rods may be necessary for joints or cracks. Tooling of the caulk or sealant is usually necessary to ensure contact with all edge surfaces and for a clean and consistent appearance.

Caulks generally refer to older oil resin-based products, which have relatively limited life span and limited flexibility. Contemporary elastomeric sealants are composed of polymer synthetics. Elastomeric sealants are more durable than caulks and have greater flexibility and wider application. Caulks and sealants can become maintenance problems, as they tend to deteriorate faster than their substrates and must be replaced periodically as a part of cyclical maintenance of the structure.

The selection criteria for caulks and sealants include type of substrate, adhesion properties, size and configuration of joint, intended appearance/color and paintability, movement characteristics, and service life. Both one-part and two-part sealants are available; the latter require mixing as part of the application process. Sealants are commonly used for a variety of places on the exterior of a building such as around windows and doors, at interfaces between masonry and wood, between various wood features or elements, and at attachments to or through walls or roofs, such as with lamps, signs, or exterior plumbing fixtures. Their effectiveness depends on numerous factors including proper surface preparation and application. Applications of sealants and caulks should be examined as part of routine maintenance inspection, irrespective of their projected life expectancy.

Installation of caulks and sealants often can be undertaken by site personnel. For large and more complex projects, a contractor experienced in sealant installation may be needed. In either case, the sealant manufacturer should be consulted on proper sealant selection, preparation, and installation procedures.

- material deterioration at or near the foundation, including loss of mortar in masonry, rotting wood clapboards, or settlement cracks in the lower sections of wall;
- evidence of animal or pest infestation;
- vegetation growing close to the foundation, including trees, shrubs and planting beds;
- evidence of moisture damage from lawn and garden in-ground sprinkler systems;
- evidence of moss or mold from damp conditions or poorly situated downspout splash blocks (Fig 16); and
- blocked downspout drainage boots or clogged areaway grates.

### *Maintenance:*

- Remove leaves and other debris from drains to prevent accumulation. Detach drain grates from paved areas and extract clogged debris. Flush with a hose to ensure that there is no blockage. Use a professional drain service to clear obstructions if necessary.
- Conduct annual termite inspections. Promptly address termite and other insect infestations. Use only licensed company for treatment where needed.
- Keep the grade around the foundation sloping away from the building. Add soil to fill depressions particularly around downspouts and splash blocks. Make sure that soil does not come too close to wooden or metal elements. A 6" separation between wooden siding and the grade is usually recommended.
- Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture or change existing grade slope.
- Reset splash blocks at the end of downspouts or add extender tubes to the end of downspouts as necessary (Fig 17).
- Lubricate operable foundation vent grilles to facilitate seasonal use; paint as needed.
- Manage vegetation around foundations to allow sufficient air movement for wall surfaces to dry out during damp periods. Trim plantings and remove weeds and climbing vine roots. Be careful not to scar foundations or porch piers with grass or weed cutting equipment. If tree roots appear to be damaging a foundation wall, consult an engineer as well as a tree company.



- Wash off discoloration on foundations caused by splash-back, algae, or mildew. Use plain water and a soft natural or nylon bristle brush. Unless thoroughly researched and tested beforehand on a discreet area of the wall, avoid chemical products that may discolor certain types of stone. If cleaning products are used, test beforehand in a discreet area; and avoid over splash to plantings and adjacent building materials.
- Selectively repoint unit masonry as needed. Follow guidance under the wall section in regard to compatible mix, appearance, and texture for pointing mortar.
- Avoid using salts for de-icing and fertilizers with a high acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry. Use sand or organic materials without chloride additives that can damage masonry. Where salt is used on icy walks, distribute it sparingly and sweep up residual salt after walks have dried.
- Use snow shovels and brooms to clean snow from historic paths and walkways. Avoid blade-type snow removers as they may chip or abrade cobblestones, brick, or stone paving. Note that use of steel snow removal tools in areas where salt-containing snow melters are used may result in rust staining from steel fragments left on the paving.

## Conclusion

Maintenance is the most important preservation treatment for extending the life of a historic property. It is also the most cost effective. Understanding the construction techniques of the original builders and the performance qualities of older building materials, using traditional maintenance and repair methods, and selecting in-kind materials where replacements are needed will help preserve the building and its historic character.

Maintenance can be managed in small distinct components, coordinated with other work, and scheduled over many years to ensure that materials are properly cared for and their life span maximized. A written maintenance plan is the most effective way to organize, schedule, and guide the work necessary to properly care for a historic building. The maintenance plan should include a description of the materials and methods required for each task, as well as a schedule for work required for maintenance of different building materials and components.

Historic house journals, maintenance guides for older buildings, preservation consultants, and preservation maintenance firms can assist with writing appropriate procedures for specific properties. Priorities should be established for intervening when unexpected damage occurs such as from broken water pipes or high winds.



Figure 17. Extending downspouts at their base is one of the basic steps to reduce dampness in basements, crawl spaces and around foundations. Extensions should be buried, if possible, for aesthetics, ease of lawn care, and to avoid creating a tripping hazard. Photo: NPS files.

Worker safety should always be paramount. When work is beyond the capabilities of in-house personnel and must be contracted, special efforts should be made to ensure that a contractor is both experienced in working with historic buildings and utilizes appropriate preservation treatments.

A well-maintained property is a more valuable property and one that will survive as a legacy for generations to come.

## Endnotes

1. *The Secretary of the Interior's Standards for the Treatment of Historic Properties*. Washington, D.C.: U.S. Department of the Interior, National Park Service, 1995.
2. Committee on Advanced Maintenance Concepts for Buildings et al, *Committing to the Cost of Ownership: Maintenance and Repair of Public Buildings*, Washington, D.C.: National Academy Press, 1990.



## Further Reading

Chambers, J. Henry. *Cyclical Maintenance for Historic Buildings*. Washington, D.C.: National Park Service, 1976.

Fisher, Charles E. and Hugh C. Miller, eds. *Caring For Your Historic House*. New York, NY: Harry N. Abrams, Inc., 1998.

Fisher, Charles E., Deborah Slaton, and Rebecca Shiffer, eds. *Window Rehabilitation Guide for Historic Buildings*. Washington, D.C.: Historic Preservation Education Foundation, 1997.

Fram, Mark. *Well-Preserved: The Ontario Heritage Foundation's Manual of Principles and Practice for Architectural Conservation*. Erin, Ontario: The Boston Mills Press, 1988.

Gayle, Margot, David W. Look, AIA, and John G. Waite, FAIA. *Metals in America's Historic Buildings: Use and Preservation Treatments*. Washington, D.C.: National Park Service, 1992.

Grimmer, Anne E. *Keeping It Clean: Removing Exterior Dirt, Paint, Stains & Graffiti from Historic Masonry Buildings*. Washington, D.C.: National Park Service, 1988.

Jester, Thomas C., ed. *Twentieth Century Building Materials: History and Conservation*. New York, NY: McGraw-Hill, 1995.

Leeke, John C. *Practical Restoration Reports Compendium*. Portland, ME: Historic HomeWorks, 2005.

London, Mark. *Masonry: How to Care for Old and Historic Brick and Stone*. Washington, D.C.: The Preservation Press, 1988.

*Preservation Briefs*. Washington, D.C.: National Park Service. The collection of Preservation Briefs assist owners and developers of historic buildings in recognizing and resolving common preservation, maintenance and repair problems.

*Preservation Tech Notes*. Washington, D.C.: National Park Service. The collection of Preservation Tech Notes provides guidance and case studies on the care and maintenance of historic structures.

Yapp, Bob and Rich Binsacca. *About Your House with Bob Yapp*. San Francisco, CA: KQED Books & Tapes, 1997.

## Acknowledgements

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# Maintenance of Brick Masonry

**Abstract:** Even though one of the major advantages of brick masonry construction is durability, periodic inspections and maintenance can extend the life of brickwork in structures. This *Technical Note* discusses the benefits and elements of suggested inspection programs and describes specific maintenance procedures including replacement of sealant joints, grouting of mortar joint faces, repointing of mortar joints, removal of plant growth, repair of weeps, replacement of brick, installation of a dampproof course, installation of flashing in existing walls and replacement of wall ties.

**Key Words:** anchors, cleaning, dampproof course, efflorescence, flashing, inspection, maintenance, moisture penetration, mortar, repointing, sealant, ties, weeps.

## SUMMARY OF RECOMMENDATIONS:

- Perform periodic inspections, preferably each season
- Determine moisture source before attempting repairs to correct moisture penetration
- Remove and replace torn, deteriorated or inelastic sealants
- When repairing mortar joints, surface grout hairline cracks and repoint damaged or deteriorating mortar joints
- Repoint with prehydrated Type N, O or K mortar, mixed drier than for conventional masonry work
- Remove ivy and plant growth that contributes to moisture penetration or deterioration of brickwork
- Exercise care in opening existing or drilling new weeps, to ensure that flashing is not damaged
- Install a dampproof course if missing or required
- Install remedial anchors and ties in accordance with manufacturer's recommendations
- Inspect masonry and correct all deficiencies before application of external coatings

## INTRODUCTION

This *Technical Note* discusses maintenance of brick masonry with an emphasis on preventing moisture penetration. All buildings are unique and may experience different problems. A given solution may not remedy similar problems on all buildings. It is therefore suggested that a repair method which will effectively suit the particular needs of a building be selected when a problem occurs.

Generally, if brickwork is properly designed, detailed and constructed, it is very durable and requires little maintenance. However, many of the other components incorporated in the brickwork such as caps, copings, sills, lintels and sealant joints may require periodic inspection and repair. Neglecting maintenance of these components may lead to deterioration of other elements in the wall.

Maintenance of buildings may be broken into two general categories: 1) general inspection to identify potential problems with the performance of exterior walls; and 2) specific maintenance to correct problems which may develop. This *Technical Note* addresses both general and specific maintenance procedures. A checklist is provided for general inspections and specific repair techniques are described.

## GENERAL INSPECTION

A thorough inspection and maintenance program may help extend the life of a building. It is a good idea to become familiar with the materials used in a building and how they perform over a given time period. **Table 1** lists various building materials and the estimated time before repair may be needed, given normal exposure. These times are based on brickwork in vertical applications, constructed of proper materials and workmanship and exposed to normal weathering conditions in the United States. Sills, parapets, chimneys and copings which experience more severe exposures may require repairs at shorter intervals.

Periodic inspections should be performed to determine

**TABLE 1**  
**Estimated Time to Repair of Materials**

Material	Use	Estimated Time to Repair (Years)
Brick	Walls	100+
Sealant	Joints	5-20
Metal	Coping/Flashing	20-75
Metal	Anchors & Ties	15+
Mortar	Walls	25+
Plastic	Flashing	5-25
<b>Finishes</b>		
Paint	Appearance	3-5
Water Repellents	Dampproofing	5-10
Stucco	Appearance	5-10

the condition of the various materials used on a building. These inspections can be performed monthly, yearly, biennially, or any time period deemed appropriate. “Seasonal” inspection periods are recommended so that the behavior of building materials in various weather conditions can be noted. Inspection records, including conditions and comments, should be kept to identify changes in materials, potential problems and needed repair. Table 2 is a suggested checklist of conditions that may require maintenance or repair. It is not all-inclusive; however, it may establish a guideline for use during inspections.

Conditions that may necessitate maintenance or repair actions include efflorescence, spalling, deteriorating mortar joints, interior moisture damage and mold. Once one or more of these conditions becomes evident, the origin of the problem should be determined and action taken to correct both the cause and visible effect of the condition. Table 3 lists various conditions affecting brickwork and their most probable sources. The items checked in the table represent each source that should be considered when such conditions are observed in brick masonry.

**TABLE 2**  
**Brick Masonry Inspection Checklist**

LOCATION		ITEM OR CONDITION	BUILDING ELEVATION			
			NORTH	SOUTH	EAST	WEST
Above Grade	Masonry	Cracked Units				
		Loose Units				
		Spalled Units				
		Hairline Cracks in Mortar				
		Deteriorated Mortar Joints				
		Missing or Clogged Weeps				
		Plant Growth				
		Deteriorated/Torn Sealants				
		Out-of-Plumb				
		Efflorescence				
		Stains				
		Water Penetration				
	Flashing/ Counter- flashing	Damaged				
		Open Lap Joints				
		Missing				
		Stains				
	Caps/Copings/ Sills	Inadequate Slope				
		Cracked Units				
		Hairline Cracks in Mortar				
		Loose Joints				
		Open Joints				
		Out-of-Plumb				
		Drips Needed				
Below Grade	Foundation Walls	Deteriorated Mortar Joints				
		Cracks				
		Separation from Flooring				
		Inadequate Drainage				
		Water Penetration				
	Retaining Walls	Spalled Units				
		Deteriorated Mortar Joints				
		Cracks				
		Out-of-Plumb				
		Dampness				
		Inadequate Drainage				
	Other Elements	Roof Overhangs				
		Gutters/Leaders				
		Seal at Adjacent Materials				
		Grade/Drainage				

## SPECIFIC MAINTENANCE

After investigating all of the possible contributors the actual cause(s) of distress conditions may be determined through the process of elimination. Often the source will be self-evident as with deteriorated and missing materials; however, in instances such as improper flashing or differential movement the source may be hidden and determined only through building diagnostics. In any case, it is suggested to first visually inspect for the self-evident source before performing a more extensive investigation as it may save time and money in detecting the cause. Such a process should always be followed if the condition involves water penetration. Once the source is determined, measures can be taken to effectively remedy the moisture penetration source and its effects on the brickwork.



**TABLE 3**  
**Possible Sources and Effects of Masonry Distress**

Observed Condition	Potential Cause of Condition								
	Incompletely Filled Mortar Joints See <i>Technical Note 7B</i>	Missing/Clogged Weeps	Plant Growth	Deteriorated/Torn Sealants	Capillary Rise	Missing/Damaged Flashing See <i>Technical Notes 7 Series</i>	Differential Movement See <i>Technical Notes 18 Series</i>	Previous Acid Cleaning See <i>Technical Note 20</i>	Previous Sandblasting See <i>Technical Note 20</i>
Cracked Units	■		■				■		
Spalled Units	■	■		■	■	■	■		
Deteriorated Mortar	■	■	■		■	■	■	■	■
Mildew/Algae Growth	■	■	■	■	■	■			
Efflorescence See TN 23 Series	■	■		■	■	■		■	
Moisture Related Stains	■	■		■	■	■			
Corrosion of Backing Materials	■	■		■	■	■		■	
Damaged Interior Finishes	■	■		■	■	■	■		

## Removing Efflorescence

Generally, efflorescence is water-soluble and easily removed by natural weathering or by scrubbing with a brush and water. Proprietary cleaners formulated specifically for use on brickwork are effective in removing stubborn efflorescence (see *Technical Note 20*).

Use solutions specifically manufactured to remove efflorescence from brickwork. Improper acid cleaning procedures such as insufficient prewetting, rinsing and strong acid concentrations may cause additional staining, etched mortar joints and increase moisture penetration in brickwork. Stains caused by improper cleaning are not water-soluble, but can be removed by proprietary cleaners.

All cleaning procedures should first be tried at different concentrations in an inconspicuous area to judge their effectiveness and potential harm to the

brickwork. Additional recommendations and cleaning methods for brick masonry are presented in *Technical Note 20*. After cleaning, the mortar joints should be inspected. Repointing or grouting of the joints, as discussed later in this *Technical Note*, may be necessary.

## Sealant Replacement

Missing or deteriorated sealants in and between brickwork and other materials such as windows, door frames and expansion joints may be a source of moisture penetration. The sealant joints in these areas should be inspected closely to discover areas where the sealant is missing, or was installed but has deteriorated, torn or lost elasticity. Deteriorated sealants should be carefully cut out and the opening cleaned of all existing sealant material. The clean joint should then be properly primed and filled with a backer rod (bond breaker tape if the joint is too small to accommodate a backer rod) and a full bead of high-quality, elastic sealant compatible with adjacent materials.

## Mortar Joint Repair

Repair of cracked or deteriorating mortar joints is very effective in reducing the amount of water that enters exterior masonry. Cracks in brickwork that are more than a few millimeters in width or that are suspected to have been caused by settlement or other structural problems (for example, cracks that continue through multiple brick units and mortar joints, or follow a stepped or diagonal pattern along mortar joint) are beyond the scope of this *Technical Note*. These cracks often require professional investigation to determine the cause and appropriate method of repair.

**Grouting of Hairline Cracks.** If the mortar joints develop small “hairline” cracks, surface grouting may be an effective measure to fill them. The impact of surface grouting on brickwork aesthetics should be considered before work begins as the appearance of the mortar joints will change somewhat. A recommended grout mixture is 1 part portland cement, 1/3 part hydrated lime and 1 1/3 parts fine sand (passing a No. 30 sieve). The joints to be grouted should be dampened. To ensure good bond, the brickwork must absorb all surface water. Clean water is added to the dry ingredients to obtain a fluid consistency. The grout mixture should be applied to the joints with a stiff fiber brush to force the grout into the cracks. Two coats are usually required to effectively reduce moisture penetration. Tooling the joints after the grout application may help compact and force the grout into the cracks. The use of a template or masking tape may be effective in keeping the brick faces clean.

**Repointing Mortar Joints.** Moisture may penetrate mortar which has softened, deteriorated or developed visible

cracks, as shown in **Photo 1**. When this is the case, repointing (sometimes referred to as tuckpointing) may be necessary to reduce moisture penetration. Repointing is the process of removing damaged or deteriorated mortar to a uniform depth and placing new mortar in the joint, as shown in **Photo 2** and **Figure 1**.

Prior to undertaking a repointing project, the following should be considered: 1) The potential for power tools to damage the brick surrounding the mortar being cut out. 2) Repointing operations should only be performed by qualified and experienced repointing craftsmen. An individual who is an excellent mason may not be a good repointing craftsman. Skills should be tested and evaluated prior to the selection of the contractor or craftsman. 3) When repointing for historic preservation purposes, refer to *Preservation Brief 2: Repointing Mortar Joints in Historic Masonry Buildings*. [Ref. 7]

The deteriorated mortar should be removed, by means of a toothing chisel or a special pointer's grinder, to a uniform depth (refer to **Figure 1b**) that is twice the joint width or until sound mortar is reached. Care must be taken not to damage the brick edges. Remove all dust and debris from the joint by brushing, blowing with air or rinsing with water.

Repointing mortar should be carefully selected and properly proportioned. For best results, the original mortar constituents and proportions should be duplicated. If this is not possible, select a mortar that is similar or lower in compressive strength. Type N, O and K mortar are generally recommended, as mortars with higher cement contents may be too strong for proper performance. Proper proportions for Type K mortars are 1 part portland cement, 4 parts hydrated lime and 11¼ to 15 parts fine sand. Refer to *Technical Note 8* for material proportions of Type N and O mortar.

The repointing mortar should be prehydrated to reduce excessive shrinkage. The proper prehydration process is as follows: All dry ingredients should be thoroughly mixed. Only enough clean water should be added to the dry mix to produce a damp consistency which will retain its shape when formed into a ball. The mortar should be mixed to this dampened condition 1 to 1½ hr before adding water for placement.

The joints to be repointed should be dampened, but to ensure a good bond, the brickwork must absorb all surface water before repointing mortar is placed. Water should be added to the prehydrated mortar to bring it to a workable consistency (somewhat drier than conventional mortar). The mortar should be packed tightly into the joints in thin layers (¼ in. [6.4 mm] maximum), as shown in **Figure 1c**. The joints should be tooled to match the original profile after the last layer of mortar is "thumbprint" hard, as in **Figure 1d**. As it may be difficult to determine which joints allow moisture to penetrate, it is advisable to repoint all mortar joints in the affected wall area.

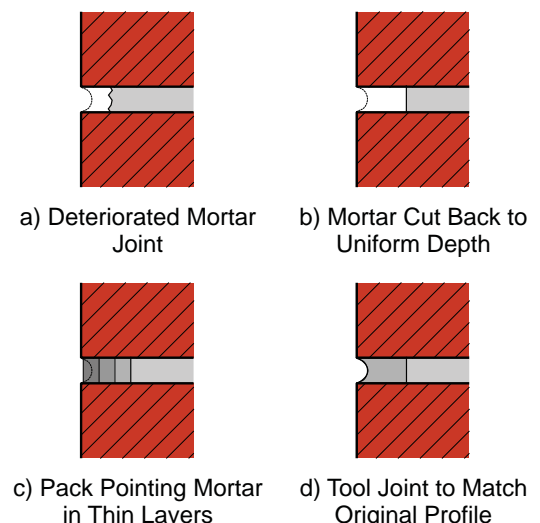
If only portions of the wall area are repointed, the repointing mortar should match the color of the existing mortar. Mortar materials should be mixed and the color matched to existing mortar that has been wetted. Several mix proportions can be made and placed on extra brick. Selection is made after the mortar specimens



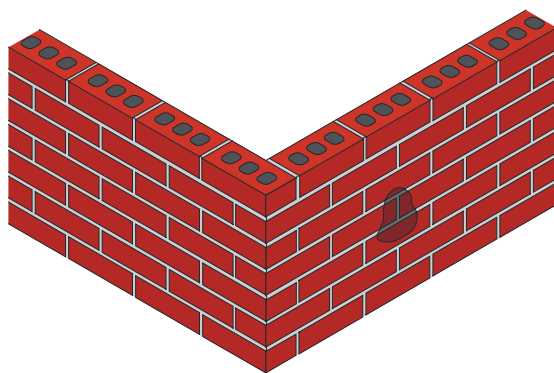
**Photo 1**  
**Mortar Joints in Need of Repointing**



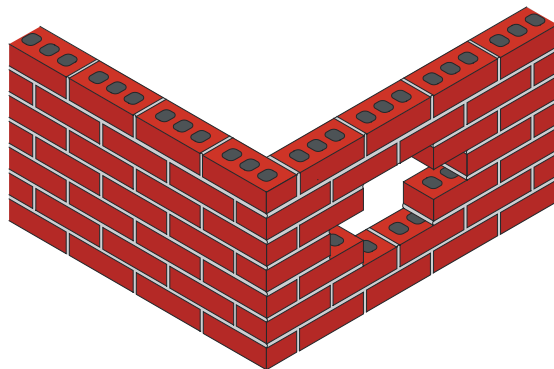
**Photo 2**  
**Repointing Mortar Joints**



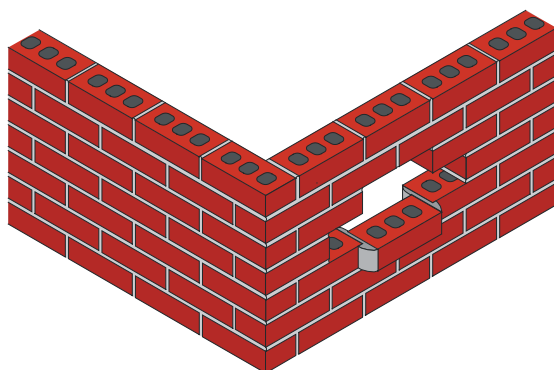
**Figure 1**  
**Repointing Mortar Joints**



a) Damaged Brick



b) Remove Brick and Mortar



c) Butter Replacement Brick and Carefully Shove into Place

**Figure 2**  
**Replacement of Deteriorated Brick**

## Replacement of Brick

Moisture may penetrate brick that are broken or heavily spalled. When this occurs, it may be necessary to replace the affected units. The procedure shown in [Figure 2](#) is suggested for removing and replacing brick.

The mortar that surrounds the affected units should be cut out carefully to avoid damaging adjacent brickwork, as shown in [Figure 2b](#). For ease of removal, the brick to be removed can be broken. Once the units are removed, all of the surrounding mortar should be carefully chiseled out, and all dust and debris should be swept out with a brush. If the units are located in the exterior wythe of a drainage wall, care must be exercised to prevent debris from falling into the air space, which could block weeps and interfere with moisture drainage.

The brick surfaces in the wall should be dampened before new units are placed, but the masonry should absorb all surface moisture to ensure a good bond. The appropriate surfaces of the surrounding brickwork and the

are dried and compared to dry existing mortar.

## Plant Removal

Certain types of plant growth may contribute to moisture penetration. For example, ivy shoots, sometimes referred to as “suckers”, penetrate voids in mortar and may conduct moisture into these voids. If this is the case, ivy removal may be necessary.

To effectively remove ivy and similar plants, the vines should be carefully cut away from the wall. The vines should never be pulled from the wall as this could damage the brickwork. After cutting, the shoots will remain. These suckers should be left in the wall until they dry up and shrivel. This usually takes 2 to 3 weeks. Care should be taken not to allow the suckers to rot as this could make them difficult to remove. Once the shoots dry, the wall should be dampened and scrubbed with a stiff fiber brush and water. Laundry detergent or weed killer may be added to the water in small concentrations to aid in the removal of the shoots. If these additives are used, the wall must be thoroughly rinsed with clean water before and after scrubbing.

To determine how the wall will appear once the ivy is removed, it is suggested that a small portion of the ivy (5-10 ft<sup>2</sup> [0.5 to 1.0 m<sup>2</sup>]) be removed from an inconspicuous area first. Repointing of the mortar joints may be necessary if the mortar has cracked or deteriorated.

## Opening Weeps

Weeps should be inspected to ensure that they are open and appropriately spaced so that moisture within the walls is able to escape to the exterior. If weeps are clogged, they can be cleaned out by probing with a thin dowel or stiff wire. If the weeps were not properly spaced, drilling new weeps may be necessary. *Technical Note 7* outlines suggested types and spacing of weeps.

Since weeps are placed directly above flashing, care must be exercised to not damage the flashing when probing or drilling. The use of a stopper to limit the depth of penetration of the probe or drill bit may be effective in reducing the possibility of damaging the flashing where it turns up inside of the brick wythe.



replacement brick should be buttered with mortar. The replacement brick should be centered in the opening and pressed into position, refer to [Figure 2c](#). The excess mortar should be removed with a trowel. Pointing around the replacement brick will help to ensure full head and bed joints. When the mortar becomes “thumbprint” hard, the joints should be tooled to match the original profile.

Mortar proportions are selected as discussed in the section on Repointing. Matching the existing mortar color is important to keep the replacement location from being different in appearance. Similarly, replacement brick must match the color, texture and size of the existing brick. Locating a matching brick may take considerable effort.

## Installation of a Dampproof Course

Moisture may migrate upward through brickwork by capillary action. This condition appears as a rising water line or “tide mark” on the wall and is referred to as “rising damp”.

Model building codes require the use of a dampproofing material on below grade masonry walls and flashing above grade. If these are omitted or improperly installed, rising damp may occur. The insertion of a dampproof course at a level above the ground, but below the first floor, may stop the rising moisture. The installation procedure can take one of two forms. One form is the injection of a synthetic chemical that forms a continuous dampproof barrier into an existing brick course. Holes are drilled into the course of brick and the synthetic material is injected. The other form of installation is the insertion of flashing through the brick wythe. One or more brick courses are removed, flashing is inserted, and the brick is replaced. Recommendations for brick removal and replacement are discussed in the following section.

## Installation of Flashing

Flashing that has been omitted, damaged or improperly installed may permit moisture to penetrate to the building interior. If this is the case, a difficult procedure of removing brick, installing flashing and replacing the units may be required.

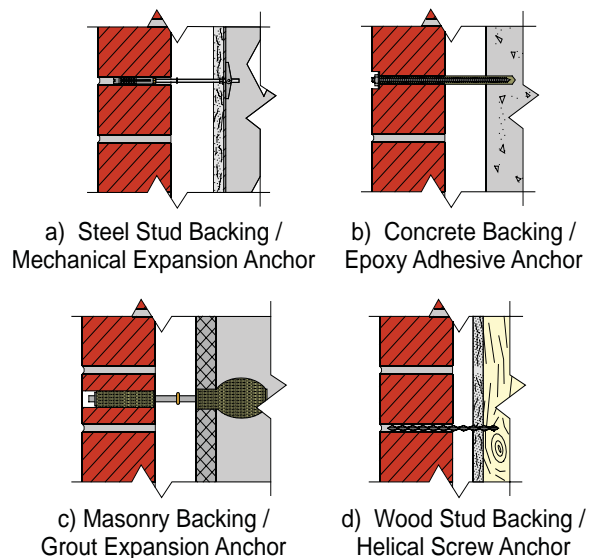
To install continuous flashing in existing walls, alternate sections of masonry in 2 to 5 ft (610 mm to 1.52 m) lengths should be removed. The flashing is installed in these sections and the masonry replaced, refer to [Photo 3](#). Alternately, temporary braces can be installed as longer sections of brickwork are removed, as shown in [Photo 4](#). The flashing can then be placed in these sections. The lengths of flashing should be lapped a minimum of 6 in. (152 mm) and be completely sealed to function properly. See *Technical Note 7* for other flashing installation recommendations. The opening is then filled as discussed under Replacement of Brick. The replaced masonry should be properly cured (5 to 7 days) before the intermediate masonry sections or supports are removed.



**Photo 3**  
**Flashing Installed in Alternating Sections**



**Photo 4**  
**Flashing Installation Using Temporary Support**



**Figure 3**  
**Masonry Re-Anchoring Systems**

## Installation of Wall Ties and Anchors

In instances where masonry walls have been constructed without a sufficient number of connectors or the existing connectors have failed, “retrofit” anchors may be used to attach the wythes or veneer and transfer lateral loads. Installing anchors in such a wall improves its strength and reduces the potential for cracking. Installation of most retrofit anchors involves drilling small holes in the masonry, usually in a mortar joint, through which the anchors are attached to the substrate. Generally, mechanical expansion, helical screws, grout- or epoxy-adhesive systems, shown in [Figure 3](#), are used to make the connection. Because the installation methods and limitations of each product are unique, consultation with the manufacturer is essential to assure proper application, detailing, installation, inspection, and performance.

## Coatings and Water Repellents

The use of external coatings on brick masonry should be considered only after completing repair and replacement of brick, mortar joints and other building elements, and careful consideration of the possible consequences. Properly designed and constructed brickwork can be expected to satisfactorily resist water penetration without the application of water repellents or external coatings. However, they may be used successfully to correct some deficiencies. For example, some coatings are helpful in reducing the amount of water absorbed by barrier walls and masonry subject to extreme exposures such as chimneys, parapets, copings and sills.

External coatings are most effective in reducing water penetration when their intended use corresponds with the nature of the existing water penetration problem. Water repellents and coatings should not be considered equivalent to essential, code-required details that resist water penetration. Use of coatings for reasons outside their intended application rarely reduces water penetration and may lead to more serious problems.

Only water repellents that permit evaporation and the passage of water vapor, such as siloxanes and silanes, should be used on exterior brickwork. Film-forming coating should not be applied to exterior brickwork. *Technical Notes* 6 and 6A and manufacturer’s literature should be consulted before any coating is applied to brickwork.

## SUMMARY

This *Technical Note* has presented maintenance procedures for brick masonry. Routine inspection of the building is suggested to determine the condition of the brickwork and related materials. If distress is noted, appropriate maintenance tasks should be performed. If the problem is moisture related, the source of moisture should be determined and corrected before other repairs are initiated.

*The information and suggestions contained in this Technical Note are based on the available data and the combined experience of engineering staff and members of the Brick Industry Association. The information contained herein must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information contained in this Technical Note are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.*

## REFERENCES

1. *Brick Brief*, “Ivy on Brickwork”, Brick Industry Association, Reston, VA, July 2005.
2. *Brick Brief*, “Repointing (Tuck-Pointing) Brick Masonry”, Brick Industry Association, Reston, VA, July 2005.
3. Grimmer, Anne E., “A Glossary of Historic Masonry Deterioration Problems and Preservation Treatments”, Department of the Interior, National Park Service, Preservation Assistance Division, Washington, D.C., 1984.
4. Higgins, L.R., *Maintenance Engineering Handbook*, Fifth Edition, McGraw-Hill Publishing Company, New York, NY, 1995.
5. Kreh, Richard T., Sr., *Masonry Skills*, Fifth Edition, Delmar Learning, Clifton Park, NY, 2003.
6. *Old House Journal*, No. 5, Vol. XIII, Brooklyn, NY, June 1985.
7. *Preservation Briefs No. 2*, “Repointing Mortar Joints in Historic Masonry Buildings”, Heritage Preservation Services, U.S. Department of the Interior, Washington, D.C., October 1998.

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## **Appendix E**

### Products

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# **Listing of vendors and manufacturers of appropriate repair and conservation products**

## **Shingles**

Jack Abeel [for white oak, Atlantic white cedar]  
Disputanta, VA  
(804) 856-1561

Shamokin Trail Shingle Co. [for white oak, Atlantic white cedar]  
Luthersburg, PA  
(814) 583-5342

Tarheel Shingle Mill [for white oak, Atlantic white cedar]  
513 Old Mill Road  
High Point, NC 27265  
(336) 841-7440

Museum Resources [for white oak, Atlantic white cedar]  
P.O. Box 911  
Williamsburg, VA, 23187-911  
(804) 966-1800

Gates Custom Milling, Inc. [for white oak, Atlantic white cedar]  
PO Box 405 Rt. 37  
Gatesville, NC 27938  
(800) 682-9663

## **Biological Cleaners for Masonry**

D/2 Biological Solution  
PO Box 3746  
Westport, MA  
(917) 693-7441  
<http://www.d2bio.com/>

PROSOCO, Inc. [manf. of Enviro Klean ReVive]  
3741 Greenway Circle  
Lawrence, KS 66046  
(800) 255-4255  
<http://www.prosoco.com/>

## **Brick**

Old Carolina Brick Company [custom reproductions]  
475 Majolica Road  
Salisbury, NC. 28147  
(704) 636-8850  
<http://www.handmadebrick.com/>

StoneArt Inc. [**custom reproductions**]  
295B California Ave.  
Church Hill, TN 37642  
(423) 357-1464  
<http://www.brickmatch.biz/>

**Gavin Historical Bricks** [salvage]  
2050 Glendale Rd.  
Iowa City, IA 52245  
(319) 354-5251  
<http://www.historicalbricks.com/>

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National Park Service  
U.S. Department of the Interior



National Center for Preservation Technology and Training  
645 University Parkway  
Natchitoches, LA 71457

Phone (318) 356-7444  
Fax (318) 356-9119

[www.ncptt.nps.gov](http://www.ncptt.nps.gov)

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				5b. GRANT NUMBER	
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				5e. TASK NUMBER W81EWF	
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14. ABSTRACT  The Matthew Jones House (MJH) is located on Joint Base Langley-Eustis (Eustis) (JBLE-E), Virginia. The house is a Virginia Historic Landmark (121-0006) and also listed on the National Register of Historic Places (#69000342). All buildings, especially historic ones, require regular, planned, and appropriate maintenance and repair. After identifying a variety of issues with the house for JBLE-E, architectural historians at the U.S. Army Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL) requested technical assistance from the National Center for Preservation Technology and Training (NCPTT) with analyzing existing materials, providing specifications for appropriate treatment materials, and making priority-level recommendations for MJH treatment by taking into account conditions and budget. The work's scope included the roofing, masonry, and HVAC systems of the structure. This report summarizes the research and findings by the NCPTT. It also includes an engineer's report and other supplemental information. This work will continue to assist JBLE-E in maintaining this historic building.					
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